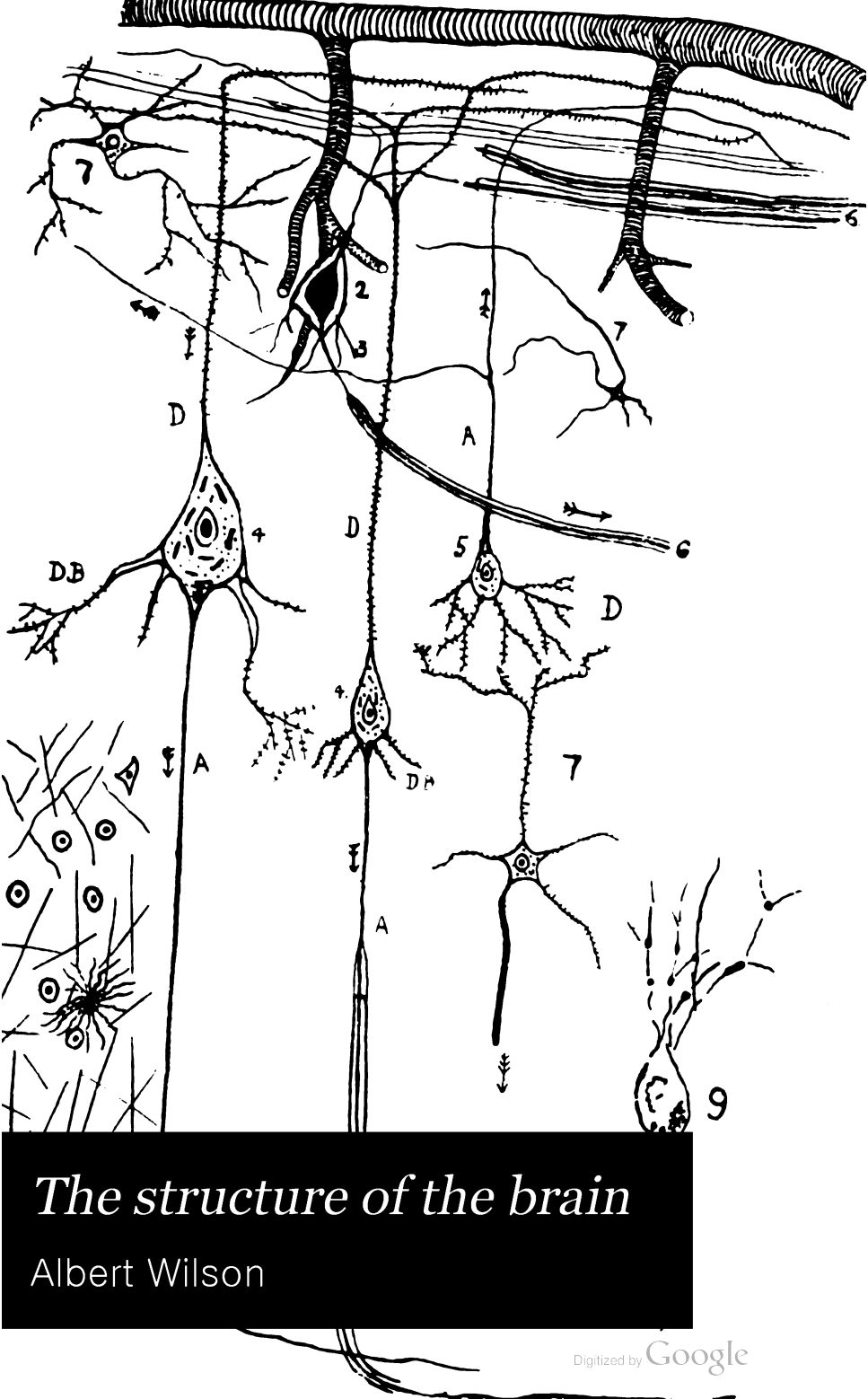

The structure of the brain

Albert Wilson

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STRUCTURE OF THE BRAIN

HOW TO UNDERSTAND AND CULTIVATE INTELLECTUAL POWER.

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STRUCTURE OF THE BRAIN

HOW TO UNDERSTAND AND CULTIVATE INTELLECTUAL POWER

BY

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Ergo hoc proprium est animi bene constituti, et lætari bonis rebus, et dolere contrariis.

Cicero.

CONTENTS.

This work is a re-issue of a more expensive book entitled "The Brain Machine" issued some time since.

INTRODUCTION.

Our lives are governed by two important factors :

Internal forces.

External resistance.

Or we may call it—

1. Our **Mental Powers.**
2. Our external surroundings, or **Environment.**

Thus to a large extent we are the **Victims of Fate.** We are but machines, yet so complex that there remains much at present unknown. By proper education, and by a knowledge of the machinery of the brain, we may not only improve our condition but may materially aid those who are in touch with us.

I first describe briefly the structure and mechanism of the brain and nervous system, avoiding technicalities, and occasionally referring to collateral subjects.

I then pass to the mechanism of thought and mind entirely as a popular subject, so that one can erect sound principles which will guide us aright through debatable subjects, and through the many trying periods and conditions which so frequently confront us.

CHAPTER I.

THE ASCENT OF MAN.

THOUGH man stands at the top of the ladder in the animal kingdom, it must not be supposed that in construction he is absolutely different from the rest of the animal world.

There is a gradual ascent or development from the lowest to the highest. Each type is the same as the next lower type with something superadded; while in the higher grades important structures are represented lower down by distinct animals.

Thus we may take the lowest form of life, such as is found in stagnant ponds, the "Monera" or "Monads." These consist of jelly-like material called **Protoplasm** without any definite organs, capable of altering its shape (Fig. 1). In this way it pushes out processes to enclose small particles of food, assimilating them.

Protoplasm is the basis of all animal tissues and textures.

Our blood contains two kinds of Corpuscles, red and white. The white are called **Leucocytes**, and are capable of wandering and changing their form, just like the Monads; this is called **Amœboid Movement**, after the Monad Amœba (Figs. 2, 3, and 4).

We owe our daily protection to these small organisms. If one of us got a poisoned wound in the skin, it would rapidly swell up, due to the

transmigration of these corpuscles to destroy and shut off this poison from the rest of the body. Under the microscope we can see these corpuscles attacking bacilli and bacteria, surrounding them and digesting them. On their activity our recovery depends.

Cilia.—Higher than the Amœbæ are organisms with cilia or lashes, by which they propel themselves in water, or draw food into their rudimentary mouths. If we take a simple sponge we have in it a community like a walled-in city. Some apertures are small, some are large; they are all connected by canals lined by inhabitants, like a huge Venice or Amsterdam.

The living material is jelly-like and lined with cilia, which waft continuous currents of water, in by the small pores and out by the large, absorbing nourishment from the water (see Figs. 5 and 6). We are dependent on the same kind of cilia to keep our breathing apparatus clean.

The nasal passages and bronchial tubes are lined with cilia, which continually bring up to the throat the dust which we constantly inhale. In asthmatics these cilia are destroyed, hence the violent spasms of coughing to remove irritating dust. The cilia are flat processes like hairs, $\frac{1}{3000}$ of an inch long. They appear structureless, but, as with Monads, their structure is too minute to unravel. They may be studied under the microscope by examining the gill (or beard) of an oyster (see diagram 7).

The Ear and Eye are with us most complex, but they are gradually evolved from the lower animals in successive stages.

Thus in the Nautilus family we have the most rudimentary eye. It is a simple fibrous sac, clear in front suggesting our cornea, and protected by cartilages. It contains a crystalline lens, and has a nerve passing backwards to a very rudimentary brain (Figs. 8 and 9).

The ear first of all appears in the Medusa, a bell-shaped jelly-fish with tentacles which swims round our coasts; the larger forms, armed with minute prongs like fish-hooks, may be unpleasant companions when swimming.

The Nautilus is not much more advanced in its order of hearing. Its ear consists of a small sac filled with fluid, containing two or three little chalk-stones called Otoliths. The vibrations which these granules receive through the water are carried by delicate nerve threads from the wall of the sac by a nerve to the rudimentary brain.

Fish have more developed ears, but as it is unpleasant to get water in the ears, Nature has deprived them of the external ear, and all is boxed in.

Nervous System.

This reaches the highest development in man. But we find nerves in the jelly-fish, Medusa, which is very low in the scale.

The Earthworm is low enough for illustration. It is marked by rings which divide the body into segments. Each segment contains a Ganglion or little mass of nerve-cells, from which spring fibres leading to the muscles which enable it to crawl. Thus a chain of nerve-ganglia runs the length of

the body. These nerves have no feeling, so that they suffer no pain when mutilated (see Fig. 10).

The same arrangement is carried out in many of the lower animals. Thus the lobster has chains of ganglia, but of much higher development. In the cray-fish there are thirteen such ganglia. There is one large mass, a rudimentary brain, in front of the mouth; it sends nerves to the eyes and eye muscles, to the ear sacs and antennæ. There are six pairs in the thorax or chest, and six pairs in the abdomen. The ganglia are always connected with each other, forming a chain.

The cockroach is a very respectable individual, with a large rudimentary brain, which sends out nerves as in the cray-fish.

There is another way in which nerve-ganglia are arranged, as seen in the Snail. There are three chief ganglia,—one in the head, one in the foot, and one in the stomach (see Fig. 11).

These various nerve-ganglia correspond to a distinct nervous system in the human body, called the **Sympathetic** Nervous System. It is a curious name, and undeserved, for they have no feeling, and might as well be called unsympathetic. They control in the lower animals the necessary functions of life. So in our case they control the heart and blood-vessels, the stomach and its digestive functions, the secretion of glands, saliva and perspiration, and other vital functions. We have a double chain of these ganglia in front of our spine or backbone, and like the snail a large mass at the pit of the stomach; hence the danger of a blow there. And we also have important masses in the chest and neck.

As soon as we rise to the Fish tribe, and later to the Frogs, Snakes, Birds, and Quadrupeds, we enter another kingdom or division, distinguished by the possession of a **backbone** or **Spinal Column.** In the lower types it is a rudimentary rod of cartilage, while in the higher forms it is composed of complex bones joined together to support the skull, ribs, and pelvis, while a bony canal or arch is formed behind to protect the spinal marrow or cord from injury. The spinal cord is a delicate and complicated nerve structure, the route of communication between the body and the brain. The number of vertebræ or spinal segments varies in different animals. In man and other mammals there are seven in the neck, twelve in the back, and five in the lumbar region. It is curious to see that a giraffe has no more bones in its neck than we have.

Frogs have only ten vertebræ, while some sharks have over 200, and some serpents over 300.

The following diagram (Figs. 12 and 13) shows very plainly the relationship of the nervous system in animals like ourselves, with a spinal cord, to the lower animals which have no spine. In a horizontal section of the latter (Fig. 12) we see a large circle with the digestive tube in the middle, and behind it the nerve-ganglia.

A similar section of the Vertebrates (Fig. 13) shows the same circle with the sympathetic nerve-ganglia in the position of the ganglia of the Invertebrates; but in addition there is a bony canal attached to the back of the circle containing the spinal cord. I will return to this subject in the chapter on Development.

CHAPTER II.

THE BRAIN: ITS COVERINGS.

THE brain is the organ of the mind. It is a most complex machine, delicate in its structure and sensitive in its mechanism. Being of such great importance it requires most careful external protection.

It is made up of two elements, **Nerve-cells** and **Nerve-fibres.** These are embedded in a soft substance called **Neuroglia,** which acts as padding.

The whole brain is enclosed in a dense fibrous case filled up with fluid, so that in reality it floats; this condition diminishes jar or shock during the movements of the body. Outside the membranous sheath is the skull, and externally the scalp.

The scalp is not ordinary skin, but a thick, tough, elastic hide, capable of resisting injury, and not sensitive to touch or temperature.

The **Skull** is a strong, thick, bony case, composed of eight bones, separate in infants, united in childhood, firmly welded together in the adult. The face is made up of fourteen bones. The skull varies in thickness in different parts, being as thin as a sixpence over the temple. In other parts it may vary from quarter to three quarters of an inch in different individuals.

There are two layers or plates of bone in the skull. The outside casing is hard and dense, whilst the inner layer is softer and thinner. In children about the age of twelve the brows develop. Under that age the brow is not developed, for the two layers of bone are united.

But at the age of puberty the two layers of the skull separate in the region of the brow to form a cavity which communicates with the nose, and is lined with mucous membrane (Fig. 14, A).

This is evident in severe head colds, when the nasal catarrh spreads up to the brow cavities. As the raised brow represents a cavity filled with air, the phrenologist is wrong in attributing perceptive qualities to it. But the brow has a certain relation to the brain, in that if the brain be poorly developed or wasted the brow would be small, whereas if the brain developed more in the frontal region the brow would be more pushed forward.

The brows may be large on account of extra development of muscles attached to them. These muscles represent the thought and intelligence of the individual in the facial expression.

People of low mental power are usually expressionless.

In old people the skull gets thin by absorption, and the skull may be not thicker than a shilling.

At the back of the ear there is a large bony mass made up of air-cells in connection with the ear.

At the back of the head there is a round lump just above the neck. There is no brain here. It is a thick mass, and the ligament of the neck is attached to it (Fig. 14, B). In the cow and horse

it is specially developed, on account of their powerful necks.

In savage races and in criminals there are many irregular bony masses on the skull.

The skull is not symmetrical; the left side is bigger than the right, and it varies in individuals.

The skull is joined on to the **Spinal Column.** The mechanism at the top of the spine is such that the head can move backwards and forwards and rotate. The whole spine has a fine **S**-shaped curvature.

In the lowest fish the spinal column is represented by a mere cartilaginous rod, which in the higher forms becomes segmented and slightly bony, the spinal cord or marrow resting on this backbone. As we ascend the scale two side arches form a protection to the marrow or cord. When we come to frogs, snakes, and birds, we find further developments and improvements, while in man they reach the highest perfection. In him the column is made up of segments or Vertebræ. Each vertebra consists of a body which is solid, and attached behind is welded on a bony round canal, to protect the spinal cord or marrow. There are apertures at the side for the nerves to pass through. (See Fig. 37.)

There are also series of processes and joints to give stability and movement.

The solid bodies of the spine and backbone are separated by buffers of dense fibrous material; this is to break the jar or shock during active movements. In old people these cushions shrivel and waste more in the front part, so that the spine

shortens and tilts forward. Thus in old age we get smaller and stoop, and incline to rest the chin on the neck.

The membranes of the brain are prolonged downwards, enveloping the spinal marrow, and finally forming sheaths to the nerves.

CHAPTER III.

THE BRAIN: ITS STRUCTURE.

When the tough membranes of the brain are cut through we find a soft pinky-brown, smooth, glistening mass, arranged in folds or convolutions. This is the **Cortex,** or **outer layer** of the brain. It is closely covered with a delicate membrane made up of small blood-vessels; this is called Pia Mater. On section we find the cortex or bark is only quarter to half an inch in thickness, and the interior of the brain is white and tougher (see Fig. 17). The cortical layer is made up of **cells,** the active thinking part of the mind, while the **inner white substance** is made up of **fibres.** The object of the folds or **Convolutions** is to obtain a larger superficial area for these active brain-cells; so that the mental activity is in direct relationship to the development of the convolutions (see Fig. 17).

In the lower animals the Convolutions are very rudimentary, except in the apes. In the lower races of mankind they are also very poorly developed (see Figs. 34 and 35).

Intellectual activity does not depend on mass or weight, but on the quality of the brain—the development of these convolutions, although probably weight and mass represent force and power. Thus great intellects result usually from these two conditions.

The brain is about one fortieth of the weight of the whole body, but receives one sixth of the whole blood-supply to nourish it. Man's brain is relatively much heavier than that of any other animal. It is for this reason that the lungs of other animals are sufficiently buoyant to support the head above water; not so with man, who sinks by the weight of his head. The only animals with heavier brains than man are the elephant and finner whale; the brain of the former is about 10 lbs., and of the latter about 6 lbs.

The **human brain averages 3 lbs.** in weight. A man's brain is 48 to 50 oz., while a woman's brain is from 44 to 45 oz. in weight. After sixty the brain diminishes in weight.

Among remarkable intellects—

Cuvier's brain weighed 64½ oz.; Abercrombie's, 63 oz.; Goodsir's, 57½ oz.; Sir J. Simpson's, 54 oz.; Dr. Chalmers', 53 oz. The African brain weighs about 46 oz. in males, and 42 oz. in females. The Australian brain 42 oz. in males, and 39 oz. in females. The Oceanic races average in brain 46 oz. in males, and 43 oz. in females. The lowest brain weight compatible with intelligence is 30 oz.

But Dr. Peacock weighed four brains over 60 oz. where the intellect was poor, and Sir W. Turner had a brain 60 oz. weight from a boy fifteen years old. Idiots with very small heads have had brains weighing from 8 to 10 oz.

Lunatics, epileptics, and idiots frequently have large heavy brains over 60 oz. In them we have frequent nerve-storms and explosions in the shape of fits and mania—cases of misdirected energy.

Just as the blacksmith's arm represents strength and force, so the delicate touch of the watchmaker's hand is the outcome of fine development and skill. So with the brain: size may represent power, but intelligence depends on refined cell development. These convolutions have each a special function which cannot be performed by any other part of the brain.

The Surface of the Brain

is therefore mapped out into **Areas.** This has been found out partly by observation in disease, and partly by experiments on animals. A certain portion of the brain may be diseased, causing paralysis of certain muscles; conversely we know, when portions of the body are paralysed, that certain areas or convolutions of the brain are diseased; while an experimenter applies electricity to different convolutions, always with the same result. It may be a leg moves, or a toe or finger, perhaps an eyebrow, or a turning of the head in some definite direction.

If we remove the brain we see that there are **two halves, right and left**; that it is large and massive, and ends below in a narrow cord about the thickness of a finger or thumb. This is the spinal cord, which represents the main telegraphic communication between the body and the brain.

The large mass of upper brain is called the **Cerebrum.** It occupies the bulk of the skull.

Below and behind is the little brain, or **Cerebellum,** also in two halves, and joined by a bridge called the **Pons** (see Figs. 15 and 16).

A line drawn horizontally backwards from the ear-hole would separate the two brains.

The Medulla Oblongata

is the lowest part of the brain, and continuous with the spinal cord. It is the centre of all the vital processes of the body. The slaughterer penetrates it with a sharp axe in killing cattle, and any head injury which causes pressure on this part is rapidly fatal. It has to do with the heart, lungs, swallowing, vomiting, and other vital functions, therefore in future we will speak of it as the representative of the **Commissariat department.**

The Cerebellum

has chiefly to do with the balancing powers. It is specially developed in the shark and eagle, which excel in their rapidity of movement. It is well developed in birds which have to fly, and proportionately more rudimentary in slow-moving birds. When we come to the frog and the tortoise we find it almost absent. An acrobat is well favoured in this direction, but those of us who cannot claim special agility are still dependent on it for stability and steady gait. We see the opposite effects where alcohol, by paralysing the cerebellum, results in staggering and reeling. The same unsteady gait occurs in tumour or disease of the cerebellum, and an innocent person may be wrongly suspected of intoxication.

The Pons, or Bridge

is of importance as a connection between the larger brain above and the spinal nerves below,

and connects the two halves of the cerebellum. It also contains roots or cells from which important nerves originate. It resembles a central telephone office, used for connecting the different districts. Though so small, on account of its position, a tiny clot or patch of softening, as in old age, may cause serious paralysis.

It has already been stated that the brain floats in a dense fibrous capsule, while another delicate membrane full of blood-vessels lies on the grey matter nourishing the active brain-cells.

During sleep the blood leaves the skull for the abdomen, and so the brain becomes pale. During mental activity, and in delirium or mania, the brain surface becomes bright red. This is due to the injected blood-vessels of this membrane, the **Pia Mater.** The disease called Meningitis, or popularly "brain fever," is due to inflammation of this membrane. After such a disease the membrane is thickened and damaged, and as a result the brain is deprived of proper nourishment and degenerates, resulting in mental impairment. The same type of disease occurs from alcoholic intemperance, and in some forms of insanity.

This great activity of nerve structures and brain requires an extra supply of blood.

The veins of the nose are so intimately connected with the chief veins of the skull, that nose-bleeding is a safety-valve for congestive headaches (see Fig. 14). There is another venous outlet at the back of the ear, a convenient place for leeches.

If the blood leaves the skull its place is filled by the clear watery fluid in which the brain floats. So

there is always a compensation of blood-pressure taking place inside the skull. The extra fluid goes in or out of the spinal canal. The brain contains cavities or **Ventricles,** which are filled with fluid (see Fig. 17, v).

In badly nourished children the brain suffers, and there is great excess of fluid formed, which dilates these cavities enormously, spreading out the brain and enlarging the skull. This is popularly known as "water on the brain," or **Hydrocephalus.** Many such are fatal in infancy, but some live. They grow up with large heads, flat on the top, and overhanging foreheads, the face looking small in proportion. Occasionally we find high intellectual development in such people, but more often fits in childhood, brain fag in youth, with much irritability and uncertainty of character, and great impulsiveness in manhood.

I once found 30 oz. of fluid in the brain of a youth aged eighteen, who was overworked in the City, got a heat-stroke, and died in three days. If his lot had been cast on a farm instead of in an office he might have lived many years in happiness, as the open-air life would have suited his slightly damaged brain.

Much may be done in childhood **to correct this condition.** Too frequently such delicate children are **over-fed** with meat and beef tea. All this is poison, as it keeps up the stimulation of a weak, exhausted brain, and the child ultimately deteriorates, especially when pressed at school. The great secret of such cases is to **let the brain lie fallow** and quiescent. Avoid all mental work, pro-

tect the child from all sources of irritation; a quiet life, and plain farinaceous and vegetable diet. Porridge and milk in abundance. Thus the body develops more fully, and is able to nourish the brain better, and gives the brain a chance. Note the effect of porridge and milk in the Scotch character and intellect.

Having briefly outlined the general principle on which the brain acts, I will now go into detail of the general scheme, and the grouping of its areas of cells and their functions.

CHAPTER IV.

THE ANATOMY OF THE BRAIN.

THE brain is **a duplicate organ,** right and left connected by nerve bands.

The right half of the brain presides over the left half of the body, and *vice versâ.* As we are mostly right-handed individuals, the left side of the brain is more educated and the more necessary in life (Fig. 15).

The nervous system is divided thus.

The **Cerebrum,** or large brain, which is the intellectual part.

The **Cerebellum,** or little brain, which directs complex movements.

The **Medulla Oblongata,** or vital centre.

The **Pons,** or bridge which connects these parts.

The **Spinal Cord,** which carries messages to and from the brain, sometimes acts on its own responsibility without the help of the brain.

The **Nerves,** which are like telegraph wires carrying messages to and from the brain and spinal cord.

Terminals, consisting in the terminations of all the nerves;

In muscles, small plates on each fibre (see Fig. 18).

In the skin as touch corpuscles, more numerous

in some parts like the fingers and face than on the back (Fig. 19). In special organs, as the eye (Fig. 20) and ear (Fig. 21), there are in each complex arrangements for the appreciation of the vibrations of light and sound.

From what has been said one gets the idea that the nervous system is like a huge **telegraph system**; in fact, it is made up of two elements—**Cells** and **Fibres.** The Cells occur chiefly in layers all over the outer surface of the brain, while other groups exist as ganglia or masses at the base of the brain, in the medulla and spinal cord.

The **white substance** of the brain and spinal cord is made up of fibres communicating between the cells. All cells and fibres are more or less embedded in soft material—**Neuroglia.** The object of this is to support and protect these delicate structures. The cells, in addition, are bathed or encased in **fluid lymph,** which fills the space between the neuroglia and the cell. There is a twofold purpose fulfilled. There is an extra protection against jar or concussion; and second, the lymph is a nourishing fluid extracted from the blood; carrying food and oxygen for the performance of the work of the cell, and removing the waste products which form as the result of nerve energy. The fresh lymph is clear, but after being used is turbid or milky. Therefore, when mental fatigue occurs, the exhaustion of the cell and the accumulation of waste material in the lymph cause a slight paralysis of the cell's action, and the result is the temporary unconsciousness which we call **Sleep.** The same thing happens in the battery cell.

If we ring our bells too much, exhaustion follows, and the cell must rest before it can work again.

So also brain workers, when fagged, should rest, and not drive their batteries too hard. Those who work continuously know too well the advantages of holiday in restoring their working powers.

THE NERVE-CELLS

present special types according to the areas in which they exist, and the functions which they perform. But they all have the following common properties:

1st. A **cell body** containing a nucleus or vital spot.

2nd. An **axon** or fibre, which carries the impulse away from the cell.

3rd. **Dendrons** or branching processes, which bring nerve impulses to the cell. There are many of the latter, so that a cell can receive a variety of messages from many sources, invoking its action (see Fig. 22). But there is only one axon, as each cell is only capable of evolving one kind of energy. Take as example, a cell leading to a muscle in the arm may receive instructions from other cells; some of them sight cells, some hearing, some smell, and others touch cells. To be accurate it would require a group of cells to control a group of muscles, but they all act on the same principle. The cells in the spinal cord exist in the grey matter; most of them are very branched. Some are spindle-shaped and small. The motor cells are large and very branched (see Fig. 26). The soft bedding material in which all fibres and nerve-

cells are placed contains a number of small round or branching cells (see Fig. 24). In certain diseases these cells multiply and form dense hard tissue, interrupting nerve-fibres and thus stopping communications. Such a disease is called **sclerosis.**

Different cells have different functions. In **the spinal cord** some are motor cells, some receive impressions of feeling, while others have to do with the functions of nutrition.

In **the brain** some cells are motor, some sensory; others for sight, taste, smell, hearing, and so forth. No one cell can either translate or perform the duties of another.

The vibrations of light striking the delicate nerve rods of the retina (see Fig. 20) are carried to the roots of the optic nerves. Here the nerve-cells transmit them in some other form of energy to the sight cells in the back of the head. The former nerve centre transmits the pictures, like a railway office which receives goods, and passes them on, keeping none.

But the optic centre is like a museum or depository which receives all that it can, and keeps them permanently for reference. The same laws apply to the other organs and their brain centres.

The cerebellum contains most beautiful cells, with richly branching processes. There are two or three layers, each made up of different types of cells (see Fig. 23).

The **Cerebrum, or larger brain,** contains five or six layers of cells, all in regular order (see Fig. 24). The chief features are pyramidal cells—one layer small, another large; other cells with processes

like spider's legs. In the motor areas there are exceedingly large pyramidal cells. In the frontal and sight areas there are chiefly very small pyramidal cells.

Nerve-fibres are of two kinds:

Medullated, or insulated with a sheath:

Non-medullated, without a sheath. The non-medullated occur as the simple endings of a nerve, or as processes leaving a nerve-cell, and also in the sympathetic.

The **medullated nerves** are covered with a sheath of a true insulating material, just as ordinary telegraph cable wires. They make up the bulk of the fibres in the brain, cord, and nerves. It is obvious that, but for this insulation, there would be great confusion of nerve motion (see Fig. 25).

The nerve-fibres are continuous with the axons of the nerve-cells; just as in electricity with copper, so with nerve-fibre, **the current** which runs so easily **along** the fibre or wire, meets with great resistance in trying to pass **across** them.

Nerve-fibres are very delicate, $\frac{1}{20000}$ of an inch in diameter; some fibrils much finer, some coarser. Nerve motion is much slower than electrical.

The velocity of nerve motion in dogs is about 90 feet per second, in man it varies from 100 to 300 feet per second. In some nerve diseases it takes two or three seconds for feeling to travel from the foot to the brain—only six feet.

It is found by exercise of muscles that the muscle-cells grow. Similarly it is found in the brain that the cells grow by exercise. In the early stage, before birth, the minute structure of

a rabbit's brain is very similar to the fully developed brain of a frog. The same applies in a modified form to the human brain.

When the child is born it is equipped with so many rudimentary brain-cells or units. We cannot add one cubit to our stature, nor can we add one more brain-cell.

But Providence is kind to us, for He has so provided that by use each cell can grow in size and strength, and in its many varied processes. This development is the result of education and use. Therefore one cannot over-estimate healthy education and good habits.

As just stated, there are two kinds of nerve-fibres—one with an insulating sheath, and the other without. The axons or outward fibres of the brain-cells when in activity are provided with an insulating sheath. Therefore by examining a nerve-cell, if the axon has no sheath we know that the cell is not fully active.

At birth the upper brain has no insulated fibres. It is quite undeveloped. The spinal cord and lower brain carry on life. As the brain grows the motor areas develop insulated fibres. The sensory fibres are insulated before the motor fibres. It is by the sensory stimuli that the motor cells are roused to activity. This explains the action of massage.

The last portion of the brain to develop is the frontal, and it is the last to lay on insulated fibres. This does not develop before youth, and some parts not till adult life.

CHAPTER V.

THE STRUCTURE OF THE SPINAL CORD.

THE spinal cord is the highway or turnpike road between the brain and the body. As a main road with telegraph wires may have small stations posted along the route, so the spinal cord in addition to nerve-fibres contains groups of nerve-cells, which can transact business for the body below without sending the message on to the brain.

Thus if a person be asleep and you tickle the foot, the message travels by a sensory nerve to a nerve centre or bureau in the cord, which sends down a message by a motor nerve to the muscles of the leg to withdraw the foot.

This is called **Reflex Action.**

If we cut a section across the cord the centre appears grey, and the shape of a butterfly. This central grey matter is embedded in white material (see Fig. 26).

The white matter is a cross-section of nerve-fibres running to and from the brain.

The grey matter consists of a delicate network in which are embedded groups of nerve-cells. The cells in the anterior horn are motor and very large. The cells in the posterior horn are sensory and fewer in number.

In the lower part of the neck and in the lumbar region the spinal cord is much thickened; this is on account of the extra nerves going to the arms and legs respectively (see Fig. 37).

We often meet children or adults with one or more limbs withered or useless, perhaps both legs affected and never grown since childhood, or perhaps a small arm hanging useless. This form of paralysis occurs in infancy, and is due to a chill setting up inflammation in the spinal cord, and destroying the motor cells in the anterior horn. Schoolboys are fond of tapping their knees to make the leg jump; this is a reflex act performed by centres in the spinal cord. There is a disease called **Locomotor Ataxia**, a **sclerosis** or hardening of tissue in the **sensory** or posterior part of the spinal column. These patches interrupt the sensory fibres, so that when the knee is tapped no news of the event can be carried to the motor cells of the spinal cord, hence the foot remains stationary. Neither can the patient feel accurately what he is walking on; the hard ground feels like wool (Fig. 26).

There is another spinal disease which is called **Lateral Sclerosis.**

In this there are sclerosed or hardened patches of fibrous tissue in certain of the white, **motor columns.** Then the patient can feel what he walks on, and as sensation is good he knows what is requisite in locomotion; but unfortunately the motor messages from the brain never reach the muscles in a proper way, for some motor fibres are interrupted by these patches (see Fig. 26). It is like having telegraph wires with flaws. In some cases the part of the spinal cord connected with the legs is alone affected, so that the gait is very unsteady. But the upper part connected with the arm may be involved, when the arms jerk and are

unreliable, and in worse cases the disease affects the brain.

The Spinal Nerves

pass out of the backbone or spinal column on each side (see Figs. 16 and 26).

There are **two roots. Anterior** or **motor, Posterior** or **sensory.**

These unite outside to form one thick nerve, and this receives branches from the sympathetic ganglia which lie inside the body on the front of the backbone. In this way they carry sympathetic fibres to the blood-vessels of the muscles and skin. There are thirty-one pairs of nerves.

The motor impulses pass from the motor areas on the brain cortex down the fibres of the white portion at the side of the cord, and thence to the motor or anterior horns, and out by the nerves to the muscles. Lateral sclerosis attacks these fibres; little patches of fibrous tissue break the current as it passes downwards. Therefore the person cannot perform voluntary motor acts; though they have the desire, the muscles cannot obey as the messages from the brain are interrupted, and the muscles cannot co-ordinate. Consequently they stagger and reel, or, if it affects the arms, jerk and spill things (see Figs. 15, 16, and 26).

The **sensory impulses** from the skin pass up to the posterior or sensory horns, and thence by fibres up to the brain surface.

As there are various sets of ganglion-cells in the cord, these often can perform actions reflexly without having as it were, to telegraph up to the brain for directions.

CHAPTER VI.

THE CRANIAL NERVES.

THERE are several important nerves which have their roots or origins on the front of the lower part of the brain. Several of these spring from the little Pons, and others from the Medulla or vital centre. It is on this account that the Pons though so small is so important.

A small clot, or softening, or pressure from a tumour affects important nerve-roots, producing vast results, as in paralysing the face and other parts.

Fig. 16 illustrates the order in which the nerves come off, and lower down shows the spinal nerves of the neck joining to form the nerves of the arm.

Three of the cranial nerves are those of smell, sight, and hearing. They have in early development budded out like shoots from the brain, and are of very fine quality (see Fig. 33).

The **nerve of smell** sprouts from the brain and passes into the top of the nose, dividing into fibrils. The upper third of the nose inside is an apparatus for smelling, the lower two thirds is the breathing chamber. We are not strong in smelling power like dogs, deer, and rabbits, which are guided by smell much more than by sight. Fish apparently can smell in water, for their brains have large olfactory lobes (see Figs. 32 and 34). Smell improves with training. In the case of James Mitchell, who was

deaf, dumb, and blind, he could tell things and people just like a dog. Flavour is a matter of smell, and not of taste. Aroma must be very dilute to be appreciated, otherwise it paralyses the nerve.

The nerve of sight or **Optic nerve** is one of the finest developments in the animal kingdom. We depend more on sight than on any other organ. The optic nerve sprouts out from the brain before birth, and ends in a small cup. This cup becomes the retina of the eye. In the retina are delicate rods and cones, which receive all the sight impressions (see Fig. 20). These impressions are carried to the back surface of the brain, the occipital lobes, and there are analysed, sorted, and registered. It is just like taking a photograph. The eye is a camera. We have a simple lens with an iris diaphragm ; the retina corresponds to the ground glass on which we focus the picture ; the optic lobes correspond to the sensitive plate, where the photograph is taken, developed, printed, and mounted in an album for future reference.

The **Auditory** or nerve of hearing is also closely related to the brain. A sac or pit forms in the brain and develops into a complicated structure called the labyrinth, or internal ear. The vibrations of sound are appreciated in it by delicate nerve-fibres which end in hairs (see Fig. 21).

Giddiness or **Vertigo** is frequently associated with this nerve. It is due to disease of the semicircular canals. There are three tiny canals in the ear, occupying about as much space as a split pea. They are set at different angles, one horizontal and two vertical. They contain fluid, which moves in

one direction. In sea-sickness we upset the current. In experiments, if the horizontal canal is destroyed, the animal reels or turns horizontally. The destruction of the others cause staggering backwards and forwards.

Three other cranial nerves have to do with the muscles of the eyeballs, and the movements of the eyes—the third, fourth, and sixth.

The **fifth nerve** is very large and important. It divides into three portions.

The first division goes to the skin of the forehead, and other neighbouring parts; we are conscious of it in neuralgia of the brow.

The second division goes to the area of the upper jaw, to the upper teeth, and cheeks, and inside of the nose.

The third division supplies the skin of the lower part of the face, and mouth, and front of the tongue. It thus enables us to feel what we have inside our mouths when chewing. When the food gets to the back of the tongue we know no more about it, and it is beyond our control, being beyond the range of this sensory nerve. This nerve also supplies the chewing muscles.

The **seventh** or **Facial nerve** is motor, and controls all the muscles of the face, and governs the secretion of saliva (see Fig. 28).

The **ninth nerve** is the nerve of taste and feeling for the back of the throat, tongue, and gullet. It has largely to do with the process of swallowing, which is beyond our control.

The **tenth nerve,** called the **Vagus** or **Pneumogastric nerve,** is one of the most important in the

body; it runs down to the lungs, heart, windpipe, stomach, kidneys, and other internal organs.

It springs from the Medulla or vital centre, and is concerned in regulating the important vital organs, in partnership with the Sympathetic. It is rather like **a brake to check overspeed.** If the heart beats too quickly, it restrains the action. It also is sensory for pain at the heart. Tobacco and belladonna poison this nerve, so that we get palpitation. It also sends a little sensitive branch to the brain, which acts as a spy or sentinel, so that when there is headache, or inflammation, or a blow on the head, it causes vomiting by acting on a portion of the nerve or nerve-centre which controls the stomach. It also sends a sensory nerve to the back of the ear,—this is called the **alderman's nerve,** because when the alderman has eaten too much he mops the back of the ear with a wet cloth to steady the gastric nerve and enable him to take in more.

This huge nerve occupies an important position in the body. It is a sort of cook-housekeeper.

It has many connections and functions; thus the sight or smell of food stimulates it to send a message to the stomach to get ready, and a free secretion of gastric juice follows. It checks the heart when overworked—a most useful office.

It supplies the lungs and windpipe, receiving messages if anything irritating enters, and causing cough to expel the same. It has to do with asthma, hence the great success in treating asthma by having regard to the stomach. It sends motor nerves to the windpipe and gullet.

Swallowing is such a beautiful mechanism of nature that it demands notice. As already stated, the food in the mouth is under the control of the will, so that the tongue pushes it about as we choose, in order to get it well chewed. When this process is complete the crushed food slips to the back of the tongue, into the area controlled by the ninth nerve and the vagus. This is beyond our control, and is an instance of **Reflex action** (see Fig. 27).

The ninth nerve is for taste and sensation for the back of the tongue and the throat. It announces the arrival of the bolus of food, and forthwith evokes a secretion of saliva and mucus (see Fig. 28), by means of stimulating the sympathetic nerves to send more blood to the glands, and the seventh nerve, which calls the gland cells into activity. During shock from fear or grief the mouth is dry, due to paralysis of these nerves. We then have to wash the food down.

This ninth afferent nerve (*i. e.* leading to the brain) also invokes the tenth nerve or vagus to start off the constricting muscles of the gullet. This is aided by the sympathetic nerves, and they form ganglia or secondary nerve-centres in the muscles of the gullet. There is a regular peristaltic action of the gullet. This means a worm-like movement from top to bottom, so that food gripped at the top end is passed regularly down to the stomach. One cannot voluntarily start this action in the gullet. It will only occur on the stimulus of swallowing food or saliva. If once started it proceeds regularly to the far end, nothing can stop it. Thus to swallow a pill, one must get

it to the back of the tongue, and away it goes independently. Experiments on animals show that the nerves of the gullet are more excitable when the brain is injured or destroyed. Their higher control is interfered with, though it is a control beyond our will power. At such times the slightest stimulus sets off violent spasms or contractions.

This thoroughly explains those uncomfortable choking sensations in **hysteria.** The higher brain is out of gear, and the gullet nerves are unusually excitable. Every time a little saliva is swallowed violent spasms occur, producing great discomfort.

In addition, swallowing stimulates the heart, and thus the spasms cause irregular palpitation.

People with weak hearts sip water, that the frequent swallowing may quicken their hearts. But many such cases would be better resting.

The Sympathetic

is a nerve system in itself. It corresponds to the chains of nerves described in the lobster and other lower animals. It consists of a chain of twenty-nine ganglia, four of these on each side of the head, and twenty-five joined in a chain, running down on the front of each side of the spine. It has to do with all the vital organs, the blood-vessels, and the glands. It stimulates the heart, and sends unsheathed or non-insulated fibres along most of the nerves in order to keep the body in proper nutrition and repair (see Figs. 28 and 37).

I have described the anatomy rather fully in case any reader desired a fairly clear knowledge of this subject without having to face many technicalities.

Though I often speak of a nerve having a certain action, it must be remembered that there is a double set of nerves, one for the right and another for the left hand side of the body.

CHAPTER VII.

THE FUNCTIONS OF THE BRAIN.

I WILL briefly describe the functions of the brain, working from the lowest to the highest. For popular purposes I shall liken the brain to an Army, occasionally to a City, or a Country, with its complex governments or services (see Figs. 27, 29, and 30).

An Army has three great divisions.

1. The **Commissariat** department. This corresponds to the **Lower Brain** or Medulla, the vital centre.

2. The **Combatant** force or **Middle Brain.** This includes the Cerebellum and the larger portion of the Cerebrum. This has to do with receiving all the news of the outer world, and directing all the movements of the body.

3. The **Commandant** or General with his staff. This is represented by the **Upper Brain** or **Prefrontal.**

Whilst an army can perform many manœuvres without the special direction of the General, there are many occasions when the subordinate officers must refer to him; whilst frequent conditions may

arise which tax all the energy of the General and his staff, and even then he may act wrongly.

The pre-frontal brain fixes the attention, and directs all the complex analytical thinking processes.

If the fore-brain be diseased, or removed (as in animals experimentally), the individual is inattentive, listless, and stupid; but more of this later.

While electricity applied to the mid-brain results in movements or actions, there is no outward result if applied to the pre-frontal. This is because the pre-frontal cells are shut off from the outer world. They are analytical, and their only connections are with other brain cells.

Here again is another resemblance to the army. The commander has no communication with the enemy except through his combatant force. He is surrounded by his staff officers.

So the pre-frontal only communicates with the areas of the mid-brain, whether sensory or motor cells. It guides, directs, and controls them.

Sight and other sensory impressions are conveyed to it in special cases of difficulty, to ask for help as to what motor cells must be put into activity.

In point of structure the pre-frontal cells differ. They are mostly small pyramids or belong to the many-shaped type, whilst in the larger motor area they are chiefly large and pyramidal.

The Lower Brain or Medulla;

the **Commissariat** in the sense of controlling the vital and sanitary arrangements of the body. The Medulla is the continuation of the spinal cord

upwards, and is built up by a re-arrangement of the nerve structures, with several important additions; such are roots and origins of important nerves and nerve-centres of vital functions, as for the heart, lungs, stomach, vomiting, heat, sweating, chewing, coughing, swallowing, &c.

Though so important to life, the Medulla is very small, less than two inches long and one inch broad.

It will be seen that many of the above functions are entirely beyond our control, while some, like breathing, are partly voluntary.

The Medulla is very dependent on a good supply of Oxygen to keep it in working order.

The Cerebellum,

or little brain, is about four inches across, and weighs about five ounces. It attains its greatest weight between the twenty-fifth and fortieth year. It lies at the back of the skull, below the level of the ear or eye. In section, one finds it is grey outside and white inside, the white portion having the appearance of a leaf in arrangement (see Fig. 16).

Its function is chiefly to regulate and steady the movements of the body. It is developed in proportion to the fine and active movements of the animal. Thus it is very large in the eagle and shark and in most birds, whereas it is almost absent in the tortoise or the frog. When it is diseased, the unfortunate sufferer reels like a drunken man and is giddy and gradually loses the use of his legs. This condition can be artificially produced by too free use of Alcohol.

The Pons or Bridge

is most important, though so small—only two inches across. It connects the two halves of the Cerebellum, and also the Medulla, with the upper brain or Cerebrum.

As the Cerebrum or upper brain is so important and requires a longer description, I will make another chapter of it (see Figs. 15 and 16).

The Cerebrum

fills the whole of the skull above the level of the ear-hole (see Figs. 15, 17, and 29). It is the immediate source of all our mental action. As before stated, it floats in a dense capsule containing clear fluid, and has a delicate mantle of minute blood-vessels covering its surface. The outer surface is grey for a depth of a quarter of an inch, and the interior is white. The grey matter contains several layers of variously shaped nerve-cells (see Fig. 24). The white substance is made up of insulated nerve-fibres. Both nerves and cells are embedded in a soft jelly-like material called **Neuroglia,** which breaks any shock or jar and acts as a support. The cells also are surrounded by fluid lymph, which bathes the cell and nourishes it. This lymph comes from the finer blood-vessels or capillaries, which carry both oxygen and food, and at the same time take away the impure or waste material from the cell, which forms as the result of its activity. The outer surface of the brain is crinkled into folds or **convolutions,** in order to give a larger area for the growth of the nerve-cells (see Fig. 17).

Brain Areas.

Experiments on animals show that each convolution has a special function, and if destroyed it cannot be replaced. Also it is found that the left brain is more active than the right. Our knowledge is obtained partly by observation in disease, but more accurately by stimulating certain parts, and observing if any muscular movement follows. Also by destroying parts and noting the effects, whether a paralysis or other loss of function.

This knowledge has been most useful in relieving suffering. Thus if an epileptic commences a fit by twitching the right thumb or hand, one would find the cause in its nerve centre on the left side of the brain. There would be some irritation causing this explosion.

We now can make a map of the surface of the brain, according to the various functions (see Fig. 29).

All impressions received from the outer world, whether by sight, smell, hearing, taste, or touch, are carried direct to the surface of the brain, and recorded in the brain-cells of their respective areas; while all movements are the result of impulses sent down from the cells in the different motor areas.

Thus we see there are areas or centres for all the sensory and all the motor functions.

The front of the brain has to do with a higher intellect, it is the Commander. Behind this comes the Combatant portion or **mid-brain.** It is best understood by consulting the diagram (see Fig. 16).

There are **five large sensory areas:**

1st. **Sight,** which is the largest, at the back. **Smell, taste,** and **hearing** have their position at the side of the head in the temporal region and inner surface. **Touch** resides at the top of the brain, while the large **motor area** occupies the bulk of the middle brain. The motor area is so arranged that the motor cells of the lips are in front, then those of the hand, arm, and so on backwards to the foot. It will be convenient here to describe **the simplest brain action.**

If a person touched anything sharp or hot, the painful sensation would be telegraphed to the sensory area. The sensory cell which received the message would wire on to the motor cells to pull the hand away (see Fig. 15). If the person was asleep, and therefore the brain not acting, such a simple act might be managed by the spinal cord or medulla. It is called a **Reflex act.** A person may be walking towards a precipice, and the impression of danger is telegraphed to the optic lobe, and from thence a message sent to the motor area, to turn and walk away. But supposing it be dark, how are the motor cells to receive instruction and guide the individual in walking? He feels with his hands and feet, and the sensory cells receive messages from them how to direct the motor cells. The impressions stamped on the brain-cell will guide the individual under similar conditions again, and this goes to constitute **experience and memory.** It illustrates the old saying that a burnt child dreads the fire.

CHAPTER VIII.

THE BRAIN-CELL.

It will be perceived that the cells are the active agents, resembling electric battery cells, evolving energy, and discharging it along wires, or in the present case nerve-fibres. A **nerve-cell** consists of a body and processes or projections. The body contains a **nucleus** which is the vital centre of the cell. It also has pigment granules. The cell shows great variety both in its form and size according to their situation (see Figs. 22, 23, and 24). Each cell has two kinds of processes, called **axons** and **dendrons.** The **Axon** is a long process, sometimes branching, and carries messages or impulses away from the brain-cell. It is insulated and becomes a nerve-fibre. The **Dendrons** are short, branching processes, like the roots of a tree or shrub. These processes are numerous beyond description, and it is probable that the large surface which they form enables the cell to obtain more nourishment. These dendrons receive impressions and carry them to the cell.

Each cell is an independent individual, it is not fused on to any other cell. It is merely in contact with fibres from other cells, sufficiently close for messages or energy to pass across, just as we see the tiny spark when two electric wires

touch. The ends of the nerves are exposed in order to facilitate this contact. At other parts the nerve-fibres are insulated or sheathed in order to prevent confusion, just as a bundle of electric wires in a cable would be insulated.

It has been found by experiment with copper wire that while electricity easily runs along it, it meets with great resistance passing transversely across it. The same has been found in the nerve-fibre.

The higher the animal, the more richly developed are these cells and processes. So that it is the distinction of intellectual vigour.

In the fish and reptile they are rudimentary, and in the child they are still undeveloped, and the fibres without sheaths. In old age and in insanity the cells shrivel and the dendrons disappear, while in youth and manhood they are abundant. These cells are our very life and happiness and prosperity. If they are overworked or diseased, they fail. Such conditions occur naturally in old age, or may happen after illness or injury.

The **degeneration** and breaking up of the cell is quite distinct under the microscope. Alcohol and depressing sedatives as bromides, antipyrin, sulphonal, and similar drugs are injurious to the brain. Oxygen in the shape of fresh air, rest and change of scene are Nature's remedies for the failing cells. If one set of cells has been overworked, they get complete rest if the mind has a change of occupation.

The worried business man, magnifying his difficulties, confused, and making mistakes through

impaired judgment, appreciates his mental diversion at golf, or his course of brain cure in mountain air. We find plenty of instances in our daily rounds, and experience it too frequently ourselves; doing stupid things, making losses, quarrelling with friends, all because our poor brain-cells are worn out. At such times some fly to alcohol. At no time is it a more dangerous poison.

When the brain-cells degenerate we find distinct changes under the microscope. The natural pigment runs into clumps; the dendrons waste or break off; the nucleus fades, and finally the cell breaks up into débris, made up chiefly of fatty globules. Paralysis or loss of cell power may mean loss of motion or of sight, hearing, or of thought analysis, according to the area or locality of the brain which is degenerating.

In the natural decay of old age, and in some progressive insanities, we are powerless to check this downward course. But in cases of brain weakness or failure from overwork, chronic laziness, or excesses, we can arrest the process by wise precautions.

We are informed that our brain-cells are in the region of uncertainty, when we get loss of memory, or inability to apply ourselves to our daily duties. Thinking becomes burdensome, and we cannot connect our ideas.

At these periods we must call a "Halt!" as the general does with his exhausted troops, until by rest, nourishment, or change of exercise they are restored to their normal working order.

CHAPTER IX.

DEVELOPMENT OF THE INFANT.

The development of the brain is very gradual. When the child is born there lies before it joy or sorrow, good or evil. It may be a helpless vessel fitted for destruction, or it may rise a pillar of strength and a tower of righteousness. The child of a criminal has a poor chance; it is of bad type. We inherit our parents' vices as readily as their virtues. One could not hope to breed an Arab from a cart horse, nor could a thistle bear figs. The lowest class are thriftless and hopeless, and, alas! very fertile.

But there is much in every rank that is capable of improvement. The mother ought to be carefully nourished and protected from worry, anxiety, and care before the arrival of her offspring.

Many a life is wrecked before its birth for want of such precautions. Many mothers among the poor nurse their children so long that the latter get rickets, water on the brain, and tubercle. If they live they are deprived of their armour for the battle of life. It is disgraceful in upper life to meet mothers who decline to nurse their children, in order to follow the gaieties of society.

No artificial food comes up to the normal. But

where the normal is deficient, other food must be quickly resorted to.

A new-born babe is a wriggling, kicking mass of flesh, all without aim or purpose. The only part of the brain in use is the medulla or vital centre. This corresponds to the commissariat force in the army.

The organs of sense develop early, then the motor powers. When the cerebellum or little brain is developed, the powers of balancing or walking are attained. The fore-brain or pre-frontal is the last to develop.

So many think the early life of an infant is of little importance. But every parent who guides the instinct of love by the higher intelligence will appreciate these suggestions.

From the very earliest period the parents must show the offspring patience and gentleness. Let the touch of the parent's hand be the balm to soothe every sorrow. In some cases where a child is very fractious the physical cause must be traced, but patience must be exhibited, however much gentle firmness is required.

The nursery must be beautiful, however humble the circumstances. One can obtain abundance of good prints of animals, fruit, and flowers, even of architectural subjects. Sometimes with horror I see a ballet girl on a nursery wall. This is a contortion of Nature.

We cannot define the exact period when the brain-cells come into activity; therefore let us be prepared to fill them with whatever is beautiful and true, for the early impressions are the most lasting.

CHAPTER X.

THE MECHANISM OF THE BRAIN.

THE brain resolves itself into a sort of huge telegraph office, receiving messages from the outer world, and telegraphing messages to groups of Muscles (see Figs. 15 and 30).

There are lower centres and higher centres. It is not always necessary for the lower to appeal to the higher. In the spinal cord there are **Reflex Centres,** which can do all that is necessary. A person tickled when asleep will move away. This is performed by the spinal cord. Expert thieves in India, by manipulating in this way on people when asleep, are able to rob them of both blankets and mattress.

There are higher reflex centres in the Medulla. Thus the act of swallowing is without any aid from the higher brain (see Fig. 27).

SIMPLE THOUGHT

is on another principle. A message is received from the eye, ear, nose, tongue, or skin, telegraphed to its brain centre and there recorded. From that cell a message may be carried to the motor areas of the limbs to perform some action. Thus take the case of railway travelling, and the care we exercise

not to get our fingers jammed in the door. If a person gets the fingers jammed in the door, it would carry to the brain centre a very painful impression. The cells would telegraph to the motor cells of the arm to pull the hand away. If this were impossible, the sight and speech centres would be invoked to bring help. The whole picture would be stamped in the optic and sensory or touch centres, and whenever similar circumstances recurred, the picture of the past would be recalled. This constitutes memory. Fortunately a mental picture depicted to the juvenile traveller saves the need of learning by practical experience.

Memory is the living over again of past states of consciousness.

Experience is not always bought so dearly, but we read or are told of various accidents. A picture is made before our mind. Our optic centres absorb it as a photograph, which we recall every time we are exposed to that small danger.

Thus we gain **knowledge** by actual experience or by description of the experience of others. It is thus that we educate children. That which is dangerous we exaggerate till the picture of pain and horror is firmly impressed on their brains. Thinking processes consist in the recall of pictures stamped in the brain—pictures of past events and conditions, which have to guide us in the present or in the future. The pictures must be absolutely true to be useful. How often parents tell their children what is not true, and think it of little import!

Often parents who are irritable or foolish act

harshly with children and frighten them where they ought not to be frightened. All this is bad policy. The child's brain fixes the impression, and at an inconvenient period may sit in judgment on the parent. For our children to be successful, they must have a proper education from the beginning, so we will consider this subject very closely.

One is apt to speak of thought as a simple reflex act, for there is first a stimulus received from the outer world, and then some action results.

By careful introspection we can trace this process in nearly all cases.

The sight or smell of food, or the sensation of hunger calls forth the actions necessary to relieve hunger. The sight of an old playmate or business friend revives a heap of ideas; and so with other details in life.

But some more complex thought occurs which seems to be evolved in the brain itself. Such seem to arise from reviving old memories. The album of mental pictures seems to fall open of itself on some particular page and start off a fresh line of thought. Though such ideas appear to start spontaneously, yet often by careful analysis we find a distinct chain of thought preceding and leading up to them. When this is not the case it is probably due to some of the cells in the fore-brain—the analytical or thinking cells—switching on the wires to optic cells in the mid-brain.

This subject is very intricate, and it is safer to understand the simpler before attacking the complex forms of brain energy.

CHAPTER XI.

EDUCATION.

THE earliest education commences with the baby, in learning the conditions necessary to self-support. It sees the feeding bottle, hears the jingle, knows the feel of the bottle and the taste of the food. Thus there are four Sensory centres engaged—those of sight, sound, taste, and touch. When it sees the bottle, a message is sent to its hand motor centre to grasp it and bring it to its mouth.

At a later stage, when the cells are developed in the speech centre, it learns that complex act. Constantly seeing its parents, and hearing the familiar names applied to them, it learns the title associated with each and to pronounce them. The parents then are stamped on three centres,—the Optic, Auditory, and the Speech centres. If you speak of its father, the auditory centre is stimulated, reviving the picture in the optic centre—perhaps stimulates the speech centre to say something about him, or the leg motor centres to run to him, or the eye motor centre to look round for him. While the child grows up, its brain is being stored with familiar objects and home scenes, and with simple actions for guidance in daily life.

The first part of **school education** consists in reading and writing (see Figs. 29, 30).

Speech.

When the child learns the letters A, B, C, it sees them, hears, utters, and copies them. These letters are stamped on four brain centres—two sensory, sight and hearing; two motor, lips and hands, or speech and writing (see Fig. 30). Frequent exercise and repetition must be continued until the impression is thoroughly stamped in the brain-cells, and in reality become part and parcel of the cell. This being so, when the child sees print it can read or write. The optic centre receiving the impression can pass on to the hand centre for writing. But speech, as a rule, also involves the aid of the auditory centre. In speaking we utter the sounds of the words, though unconscious of this special stimulus. If sight be absent we teach the blind to read by touch, and the message is received by the sensory skin or touch cells of the fingers, and sent on to the speech centre (*viâ* the auditory centre to get the pronunciation). In case of deafness lip reading is employed, through the optic centre.

Our extension of ideas is by the use of the sensory and motor centres. **Words** come to have a living meaning. Thus a lemon or orange are impressed on the centres of sight, smell, taste, and touch, and through conversation on those of hearing, speaking, and writing. The more centres employed the better the memory.

MEMORY

is the power of registering words and ideas in the brain, and also the power of recalling them. Thus if I smell an orange in the dark, a sight impression of its shape and colour is at once revived. If I mention a lemon, the hearer sees a lemon and recalls everything about it.

Each centre when stimulated can call up one or more associated impressions from other centres.

Memory is of two sorts, **good** and **bad.** We cannot hope to recall a lesson which is not thoroughly learnt. It is clear that it is easier to remember a lemon or a horse, than a mathematical formula or a poem. The reason of this is, that whereas the former have impressions stamped on several centres, as sight, touch, smell, taste, hearing, speaking, and writing, the latter are stamped merely on the speaking, hearing, seeing, and writing centres. These centres are not nearly so retentive. In repeating poetry, it is the sound of the last line which suggests the next line. Hence poems with rhyme are easier to learn than those without. How difficult it is to repeat a particular line in a poem without first repeating the earlier lines!

Though poetry is revived in the sight and sound centres, it is not so well fixed there as simple objects (see Fig. 30). Thus a lemon is stamped twice in the optic centre—once as a yellow oval fruit, and once as the printed or written word. So there is **an optic word centre** and a **pictorial** or photographic centre. The poem or formula is only stamped in the former centre. But we may

slightly invoke the aid of the pictorial centre by underlining or decorating the page from which we learn. Even a thumb mark on a page may help us to recall printed matter.

In the auditory centre there is one portion for **word-sounds.** This alone is of use in retaining any knowledge learnt by rote or repetition, whereas in using the words dog or cat, not only is the word centre impressed, but the peculiar sounds which these animals make are also impressed. If we speak of paper, in addition to the word sound, there is the peculiar rustle stamped on the auditory centre. One can test the accuracy of these facts by suggesting a variety of familiar names and objects. If we talk of a pencil scratching on a slate, it sets the teeth on edge as if it actually occurred. This indicates that the strength of education is to make **a network of impressions** in the brain, by stamping impressions in as many brain centres as possible, so interwoven that they cannot be separated, and so associated that the one recalls the other.

Thus in teaching a child about Newcastle, it hears, writes, and pronounces the word. It studies the map, and probably with the aid of pictures learns a great many interesting facts about its history and industries. There is in reality a small album of photographs in the brain relating to this one word. There is old Father Tyne, the old Norman Castle, the first railway engine, the high-level bridge—a marvel of engineering, built by George Stephenson's brother,—the immense coal-fields, the ship-building and iron industries. So

there may be twenty ideas associated with one object, and the suggestion of one idea may recall any of the others. Geography and history, and other dry subjects, are taught much better now on this principle than in former days. The impressions also are much more lasting.

It is lamentable how many subjects we forget.

If we speak of a familiar person or place, we at once recall the picture or photograph of the subject or person. Think of any relative or friend, or building like St. Paul's or the Tower, and we see them before us.

But if many years have elapsed since seeing a friend, the photograph in our brain may have faded, and it is an effort to recall it. More difficult than to recognise our friend is to remember his or her name, for the simple reason that word memory fades away more easily than visual images.

Those who photograph know too well that a good impression requires correct exposure. **Under-exposures** are poor, and do not last. It is the same with our brains. We cannot learn without drilling the subject-matter into our brains—frequent repetition when learning by rote; and careful fixed attention from the special guidance and energy of the pre-frontal or fore-brain, which acts as the commanding officer. Imagine the case of an assault or two people fighting, and a stranger witnessing it. A few days after, the witness has much difficulty in recognising the offenders. The reason is that he could not for a sufficient time make observations, and possibly other circumstances are against him. It is an under-exposed

photograph. Many people also are not trained to use their eyes. A quick observer might have noted several points which could not fail to commit the offenders. It is a great matter to train one's self to observe. **Accuracy and speed come with practice.**

In order to understand a subject we must have a previous knowledge of it. To talk of Paris or Norway to one who has never been there, conveys no information. But one can give instruction, either by pictures or descriptions, comparing with familiar or known objects. To talk of the Tropics is a blank to most of us, not having visited them. But from picture and description we realise a little of the heat, the natives, the animals, and the type of scenery. Yet, though we may see their animals and natives, we can never realise the scenery without seeing it.

To one person the words dynamo, man-of-war, or telephone are full of detail and knowledge. But to those of us who are not experts, they are almost blanks. Much of our education must depend on comparative descriptions or imaginary or mental pictures.

It is important for those who educate or write to teach accurately. Many travellers are too flowery in their description, and many places are much exaggerated; thus everyone is disappointed on approaching St. Peter's, after hearing so much of its grandeur.

We see, then, that **the brain** is like a **big album of photographs,** and other sensory impressions. We must store the brain with accurate impressions,

put in the good and **keep out the evil.** I strongly maintain that in **the training of children** they should be sheltered from evil, and kept in ignorance of it. The natural tendency is to grow crooked, so that while they are young and weak they should be propped all round until capable of self-government.

One is apt to forget that **brain energy soon gets exhausted** in the young. The long hours in school and the evenings spent in preparing lessons and cram are very injurious to weak brains. The brain-cells cannot so readily retain the impressions. Hence the value of games in not only diverting the attention and resting the brain, but also bringing a fresh portion of brain into action, the large motor areas.

For many, music is a great rest and diversion. Its charms are the same to the hearing as beautiful scenery is to the sight centre.

If the mind is weary from work, there is a tendency to **mental depression**; even exhaustion of the body may produce the same condition. At such times physical rest and mental recreation are in great demand. The more educated we are, the more joy we are capable of. Conversation on agreeable subjects makes us happy by arousing pleasant visions and sensations. Similarly we can arouse miserable depression by gloomy suggestions.

CHAPTER XII.

AUTOMATIC ACTION.

As the result of education by constant repetition, many actions become unconsciously performed. Thus the act of reading aloud may be done automatically, our thoughts wandering on other subjects. Many daily actions likewise, such as dressing, winding up one's watch at night; how often one has to reflect if the watch is wound, and perhaps get up during the night to see! Yet the brain has fulfilled its duty.

During **attention** the fore-brain is active, the eyes are fixed, and the facial muscles attentive. But if we are **listless** and not interested in the subject before us, the eyes diverge and look into distance. One may read whilst walking through a crowded street, or play music, or even carry on a conversation, yet the fore-brain is pre-occupied, and the rest of the brain action is quite mechanical.

Few things are so difficult to acquire as **learning music**. Yet the accomplished musician becomes an automaton.

The beginner engages five brain centres, three sensory and two motor.

First, Sensory.—Sight, in reading and striking the notes.

Second, Motor.—Speech, in repeating them.

Third, Sensory.—The word hearing centre.

Fourth, Motor.—The hand centre, in striking the notes.

Fifth, Sensory.—The hearing centre, which retains the musical sounds.

By continued practice all these acts become automatic, so that the player can rattle through complicated music, either thinking or talking about other subjects. But if a false note were struck the harmony of the mid-brain action would be interrupted, through the medium of the fifth centre as above. The fore-brain would be aroused, the attention fixed, and the error corrected.

Habitual acts are performed with less effort and fatigue than when attention is required. The mid-brain alone is at work, the fore-brain is at rest. The mid-brain is much larger and has a greater blood-supply. One may apply these interpretations to many daily actions. Contrast the automatic way of walking through the crowded city, with the close attention required to cross a glacier, to avoid falling into dangerous crevasses.

CHAPTER XIII.

THE FORE-BRAIN.

We have seen how the mid-brain acts as the combatant force, and may automatically act on its own responsibility according to the sensory impressions received. But the combatant force frequently has to invoke the aid of the fore-brain, which acts as the **Commandant** or General, carrying to it the outer or sensory impressions, and seeking for motor directions; but the fore-brain may be required to analyse the sensory impressions. In all processes of learning, the fore-brain is active in fixing the attention, which is essential for stamping ideas in the mind.

We soon find out **the quality of the fore-brain.** One pupil is bright and learns quickly, another is dull and inattentive. It is the duty of the teacher, patiently to trace the cause of mental dulness.

It may be **congenital.**

The child may be feeble from birth, in which case it is no use forcing much education. What is necessary must be given in small doses and with much illustration. Fatigue must be avoided. It would be just as absurd to try and force a cripple to walk.

The cause may be **temporary** from illness or Anæmia of the brain, or want of exercise and fresh air.

It may be sheer **Nervosity** and want of self-confidence. Many children are afraid to hear their own voices. Such cases demand great patience from the teacher to gain confidence and give courage.

Experiments on animals show that the fore-brain fixest he attention, and controls the memory. A bird after the fore-brain is removed sits on the perch, listless and unhappy. It will die of starvation, though food is within reach. But if grain is put in the beak it will swallow it. This is due to the machinery of the mid-brain—the sensory nerves of the tongue calls on the muscles of the beak or jaw to grip the bolus and swallow.

The same with the dog; when his fore-brain is gone he will smell food without remembering its use. If attracted to it he will approach it and then turn away, but if put in the mouth will eat it.

The same occurs in those suffering from **Tumour** of the pre-frontal brain. There is great loss of memory, no power of attention, absent-mindedness, general bodily weakness, and headache. There is no paralysis, because no motor cells are attacked. In the case of a gentleman so affected, he continually in business forgot to fulfil his promises. Though of the highest integrity, he took no interest in morning prayers, looking at a picture book while his son officiated. The sound got no further than the auditory centre, and his fore-brain could not analyse it (see Figs. 27, 29, and 30).

Experiments with **electricity** show that certain areas have to do with knitting of the brows, fixing of the eyes, cocking up an ear, or turning the ear

or head to one side as if to catch sounds. All these movements fix the attention.

The fore-brain also guides and controls the **memory.** In this way it acts as a **reference book** or **index.** In the effort of memory the fore-brain is aroused, as it were, to connect the switches on to the right wires. Thus the dog without a fore-brain sees and smells food. It cannot remember what it did with the last food. But the fore-brain or director general, receiving the news of the food from the smell and sight centres, switches the message on to the motor centres of the jaws to seize the food. The fore-brain is the General commanding. By attention it analyses everything, and by power of recall or memory he can bring back past events when occasion requires. When complex scenes arise, as in the battle of life, then it has much analytical work in deciding on action required.

CHAPTER XIV.

MEMORY.

MEMORY consists, 1st, in the power of retaining knowledge or experiences; and

2nd, the power of recalling past knowledge or past states of consciousness.

Thus if we heard some grand music five years ago, and the piece was being discussed, the name mentioned would, from the word hearing-centre, rouse a stimulus in the music-hearing centres, so that the piece would be recalled or heard over again. Few people could do more than recall the stirring parts which fascinated the attention, and were therefore retained. Insignificant parts would rapidly fade from the auditory centre, like under-exposed photographs.

In remembering that music we recall the exact moment of consciousness when we heard it, and probably also recall many visual pictures or memory photographs of that particular event, people we were with, and so on.

It is important **to improve the memory.** The most difficult to remember is that which depends chiefly on the speech and hearing centre, that which is learned by frequent repetition. It is good to persevere with children in this method of learning,

stimulating the growth of these brain centres. It helps them in after life to retain uninteresting but necessary details. Many children have great power of retention. Even imbeciles have been known to remember columns of newspaper after one reading.

Orators have these organs well developed. The extra brain development causes great enlargement over the left temple, this being the region of the speech and hearing centres. But there is no one seat of memory; all the brain centres are engaged.

Memory and **Attention** go hand in hand, and are inseparable. We may sit in front of a preacher and hear every word of his discourse, and retain nothing, because our attention has not been engaged. Our pre-frontal has been at rest, or it may have been occupied in other thoughts. We may have been arousing a distinct set of mental photographs on some subject quite apart.

If we wish **to recall a subject** the stimulus must pass to the pre-frontal or registry office, whence the stimulus is sent to the brain-cells containing the sensations to be revived (see Figs. 27 and 29). We may hear or see, but not perceive. Without the exercise of the pre-frontal we can neither retain nor recall. Fibres are found to pass from the pre-frontal to every part of the brain.

It is most difficult to remember names and concrete subjects. For aid one must often resort to **mnemonics.** Each person can follow his own methods; they are like pegs to hang words on. I adopt a method of associating the name to be remembered with some familiar object. Thus I had once to remember the name Hertz. As I always

forgot it I associated it with the great Dr. Hertz of the Panama mystery. If I had to remember the name Martin I should think of swallows. Endeavouring to recall the names Dr. Hertz and the swallows would bring them both back.

Though memory requires the fore-brain for education, and disappears in disease of the fore-brain, yet it is probable that in the processes of thought involving memory the fore-brain may often remain inactive. Such instances occur where the brain acts automatically. An extreme case is that of playing music; no effort of memory is put forth each time a note is seen or heard.

Also in repeating poetry there is no fore-brain action if the poem is thoroughly learned. The word-sound and speech centres manage it unaided. The same occurs with typewriters and shorthand or telegraph clerks.

There are, as it were, short cuts between the sight or hearing centres and the motors of the fingers.

In early days the fore-brain was necessary to engage the centres; but once educated, new and shorter routes of communication seem opened up.

This may be illustrated by the case of a lady who completely lost her mental faculties, but being an accomplished musician, was able still to play music as before. Her fore-brain was gone, she could not learn any new piece, but the short routes in the undamaged cells of the mid-brain remained intact.

CHAPTER XV.

SPEECH.

LANGUAGE is divided into the emotional and the intellectual.

I. The **Emotional** is communicated by gesture or emphasis, methods which attract the feelings or senses.

II. **Intellectual,** or vocal utterance, or **Speech,** is that which we will now deal with.

Speech also is subjective or sensory, and objective or motor.

A. The **subjective** department is under two functions:

1st. The **receptive** or sensory organs, which receive impressions, as the eye, ear, &c.

2nd. The **analytical** or brain-centre, which interprets the impressions.

When we see a horse our brain-centre interprets everything for us from past experience. But if we saw or heard anything quite new for the first time, then our brain-centre might record it; but we would not understand it until it was explained. This explanation would depend on illustration, and the fore-brain would be called upon to analyse and revive comparative mental photographs.

B. The **Objective** or **Motor language** consists of—

1. The central head office or **motor areas** of speech and writing, which are on the left side of the brain, about the "temple."

2. The executive or **motor nerves** to the muscles of speech and writing, whose roots are found in the lower brain and spinal cord.

Let us illustrate this with the term "St. Paul's Cathedral." Our eye and ear receive impressions, which are transmitted to the sight and hearing centres.

These are the subjective or sensory functions. The two objective or motor departments are the speech and writing centres and the motor nerves of the lips and hand (see Fig. 30). Of all these centres the auditory is the most important; the sight comes next. Children born deaf are usually dumb; while children who become deaf early in life often lose the power of speech, unless taught lip reading.

Reading, writing, and thinking are compound acts, involving all these motor and sensory centres. When we read aloud the eye and optic centre are stimulated, thence a message goes to the auditory centre, producing the sound of the words, and thence to the speech centre. When we read silently we unconsciously articulate the words, and the auditory centre is also stimulated. We notice this when reading a difficult passage. We slowly pronounce the words, and in that way impress them on the speech and hearing centres.

Any one centre can stimulate the other (see Fig. 30). Thus hearing about St. Paul's stimulates the optic lobe to produce a picture of it, and if we

want to write, the optic word centre sends a message to the motor writing centre, or if we want to speak about it the auditory word centre sends a message to the speech centre (see Fig. 30). It is considered that writing and speaking being automatic and rapid in action have two special centres, one for words properly formed in the speech centre, another for language in the optic centre to guide us in writing. We study this subject more correctly by considering cases of different areas destroyed by disease or experiment.

The left side of the brain is more active in right-handed people. In speech it co-operates with the right, which is sometimes capable of education when the left side fails. There is a convolution called after the discoverer, Broca, in the left frontal region near the temple, which is the **Speech Centre.** In a small apoplexy the artery supplying this centre bursts, and therefore speech is paralysed. If a larger artery bursts nearer the heart, as it radiates or branches like a fan, so it may cause paralysis of the whole motor area, then one has paralysis of speech and the right half of the body. But if the apoplexy is on the right side, you get paralysis of the left half of the body, speech being preserved, or only lost for a short time (see Fig. 17).

We call **loss of speech Aphasia,** and it is either motor or sensory (see Fig. 30).

1. Motor.

If the **speech centre** alone is destroyed, one may see, hear, think, and write. But there is no com-

munication by speech. Such a person might make a will; his intellect is not impaired. This is, however, a medico-legal question.

2. If the **hand centre** is destroyed one is unable to communicate by writing, but can speak, read, or hear. Such a case is rare, as the artery usually bursts at such a point as to shut off both speech and right hand. A large artery is like a tree, it sends off branches in all directions, and one can easily understand how little damage occurs if a terminal twig breaks, compared with the great damage if a main stem or large branch is destroyed.

Sensory aphasia is more wonderful and complex. It consists of word-deafness and word-blindness.

3. Word-deafness.

The hearing word centre is most important; when it is paralysed there is complete deafness to words or spoken language, yet all other hearing is perfect, only one spot in the centre of hearing is damaged. A person may hear a watch tick, but cannot hear the word watch. There is no understanding of speech, for words have no meaning, but the patient can speak and read and write. But the sight of an object, as a lemon or horse, does not call up the name of it. So the patient uses wrong words for things.

4. Word-blindness

is due to destruction of the visual word centre. Those affected cannot see words, yet their sight is otherwise good. They cannot write from a copy

because the hand depends on this centre for its impulses. A patient could not tell if writing was upside down or not, but might hear and speak. The person may, however, write from dictation or of his own will, but cannot read what he has written.

As a rule two or more centres are involved, and usually they can say yes or no, but quite incorrectly applied. Even where there is partial speech, names may be misapplied. They might call a spoon a fork, and yet know the difference if asked to touch one or the other, or they may misapply words in writing.

We often commit these mistakes ourselves when the brain is fatigued, and the same happens in old age or brain softening.

This subject is so complicated that it is always ripe for discussion in medical circles; therefore I hesitate to bring it into a popular work. I only do so to show the wonderful mechanism in speech. I have endeavoured to make all so simple that I might be attacked for want of scientific accuracy. When people are word-blind or word-deaf, they resemble those who have in youth learnt a foreign language, as German or Greek, but quite forgotten it. They can read or write it, but the words convey no meaning.

CHAPTER XVI.

DEVELOPMENT AND EVOLUTION.

From the experimental study of the brain we see that each area and convolution has its special functions.

If one part be destroyed it cannot be replaced by another part.

Intellect is the total result from the complex working of the brain.

The brain is to the body as the head war office is to the country. They both receive sensory impressions telegraphed up from every part of their possessions, and they both can reply by giving directions for action in any part. It is not every message that reaches the Fore-brain in one case, or the Commander-in-chief in the other. There are several subordinate officials all the way down relieving the higher staff. The higher developed the fore-brain, the more talented the commander, so much more brilliant are the results.

No child is born with a fully equipped brain or telegraphic system. It is quite rudimentary. It is gradually developed from the lower to the higher.

Nor is man entirely different from the lower animals. There is a gradual evolution from the lowest jelly-fish to man.

In man there are two great systems.

THE SYMPATHETIC,

which corresponds to that in the lower animals, as the cockroach and worm (see Figs. 10 and 37). It is made up of chains of ganglia running the length of the spine or backbone in front, and sending delicate fibres to the blood-vessels, heart, lungs, stomach, glands, and other vital organs. These nerves are not insulated, they have no sheath like the spinal nerves. There are some special large masses or **ganglia** in the neighbourhood of the heart, stomach, and abdomen. These are important vital centres, for a blow at the pit of the stomach may prove fatal. By referring to Chapter I, Fig. 11, one can compare these nerves with those in the lobster and snail. In the former we have a chain, and in the latter three chief masses corresponding to the three masses just described, and approaching them in function.

THE CEREBRO-SPINAL SYSTEM

consists of the brain and spinal marrow; the latter, as it were, added on to the outside of the spine or backbone, in a bony canal. This is more plainly shown in studying a sectional diagram.

In the **Invertebrates**, or non-backboned animals, a section shows a circle containing the stomach, heart, and behind the nerve-chain (Fig. 12).

The **Vertebrates**, or backboned animals, have the same arrangement inside the body, but added on outside is a canal containing the spinal marrow (Fig. 13).

We see from this that **our sympathetic chain** corresponds to the nerve-chains of the lower animals. We know that our sympathetic nerves have no sensation, and we may safely infer that flies, lobsters, and worms are also devoid of sensation. This is some consolation, considering the great loss of life among the lower animals. These sympathetic nerves are of the utmost importance to our daily life. They are like the domestic servants of a large household. When they work well we are in comfort; if they rebel we are miserable, suffering from functional diseases. Some of these are classed as **Hysteria**, a popular misnomer for a variety of true diseases.

The most rudimentary Vertebrate is connected with the Invertebrata, one species of which is furnished with an appendage containing a spine. In that way the **Appendicularia** and the **Amphioxus**, or mud-fish, forms a connecting link between these two classes (see Figs. 31 and 32). The former (Fig. 31) is a small animal with a stomach, heart, and nerve-chain. It can build a house around itself in an hour. It is often found on our coasts. Its appendage contains a soft rod with a nerve-chain resting on it. The mud-fish (Fig. 32), instead of a bony spine, has a soft rod with the spinal marrow on it.

As we ascend higher to reptiles and birds we get more complex spines, nerves, and brains. According to the special functions of the animal so is the development of the brain. In the fish the brain is chiefly in masses or lobes, for smell and sight, or a large cerebellum if they move actively. Most fish

have nasal sacs and keen scent in water. Fish also hear well. There is no outside ear or drum, but a well-constructed inner ear or labyrinth shut inside the skull. The vibrations of sound reach it through the skull bones. We can hear sound through our skull if a tuning-fork be placed on it. If the drum be diseased, people hear better through the skull than through air.

The shark and crocodile, and many birds, have well-developed **Cerebella** to guide their rapid flight in air and water; whereas the frog and toad, which are so limited in movements, have little or no cerebellum.

The **Medulla** is simple with man as compared with the lower animals. This looks as if life is a greater pleasure to them than to us—a more happy digestion, more pleasure from breathing, and so forth.

The higher brain or **Cerebrum** is more highly developed in man than in other animals, while the ape is intermediate. Dogs are specially well developed in the smelling lobe, so also are the deer tribe and the rabbit. They gain all their information by scent. We are chiefly seeing animals, but some primitive races have great power of scent. The Peruvian Indians can smell people miles off and discriminate between Europeans or negroes. The Sahara natives are said to scent forty miles off. Special faculties when developed among races are transmitted. Thus we find races of wood carvers among the Swiss, and of weavers in India.

By studying the **Embryo** we see gradual evolu-

tion, and at certain stages it would be difficult to say if it were to turn out a fish, bird, or higher animal.

The **brain is developed** from a mass of **cells,** which takes the form of a **hollow tube.** It then becomes constricted and forms masses—fore, mid, and hind brain (see Fig. 33). The medulla or vital brain develops at the posterior part, and the spinal cord behind that. At the front of the brain shoot out two stalks on each side. One of these stalks becomes cupped at the end like an egg-cup. The cup forms the retina or nervous structure of the eye, with all its minute transformations into little rods which receive and detect light, colour, and form. The stalk forms the optic nerve.

The other bud forms the olfactory bulb; the stalks give off the nerves.

On the posterior brain there forms a pit, which ultimately develops into the complex labyrinth or inner ear. The front half of the eye and the middle ear, or drum, are tacked on later. Being of one origin, one sees the reason why the brain and inner ear and eye re-act on each other in disease.

When the child is born the medulla or vital centre is well developed. It is the Commissariat, and is essential. The senses develop next, then the motor areas and cerebellum to guide them. In youth the sensory centres or receptive powers are active, storing up outside impressions.

The pre-frontal or fore-brain is the last to develop; hence children are wayward, impulsive, and determined. Their fore-brains have not been developed sufficiently to direct their judgment.

The kind-hearted child, lacking experience, believes the impostor, and will almost separate from parents to fight his cause; ignorant sentiment, blind to reason.

The impulsiveness of youth continues till the fore-brain is developed in manhood, when wisdom reigns if the brain is healthy and the education true.

The most important faculty to cultivate is **Self-control** or **Inhibitory power.** It must be commenced in infancy, and attains its greatest power between forty and fifty, after which period it fails; but if the faculty is cultivated it remains through life and brings a happy old age. Otherwise, by self-indulgence, in later life many lose all self-restraint. After sixty the brain fails; it begins to shrink; later impressions fade while those of childhood remain; and what is termed second childhood appears. It is like the mirror of his past life. Happy is he who reflects what is good and pure; it is worse than death when otherwise.

CHAPTER XVII.

THE NECESSITY OF A BRAIN.

It may seem absurd to suggest the need of this important organ.

But the way to consider this subject is to see, experimentally, how animals get on when the brain is removed.

These experiments are always conducted with anæsthetics and antiseptics.

It is found that any brain operation on the lower animals, however slight, upsets the whole organ. Thus if a small portion of the brain centre which moves the left hand were cut out or injured, it would so irritate the brain that the other centres would be stimulated.

Twitching of the left arm follows, then of the left leg; finally it crosses the brain, and the right arm and leg become agitated until a general epileptic convulsion occurs.

This has thrown a great deal of light on some kinds of epilepsy, for we know that it is the result of congestion or irritation of one spot spreading gradually to the motor areas.

The brain of the fish is very rudimentary, so much so that if it be removed the animal appears

to get on as well without it. It continues to swim, but is deficient in guiding power.

A frog has a higher development. If a frog's brain be removed, leaving the lower brain so as not to interfere with the heart and lungs, the animal loses all power of will. If it be placed on a table and a line drawn round it, it will remain there till dead; but if thrown into water it would swim, responding to the stimulus. If it were fed, and kept in natural surroundings, it would act as if nothing had been done, even catching flies and hybernating.

If a bird has the brain removed, leaving the lower brain, it will neither feed nor fly, but responds to external stimuli as light or sound. It has no spontaneous will as in health, so that it never recovers like the frog. It depends more on its brain, and bears the loss badly.

If the same be done to a rabbit or dog, the shock is greater. If they recover they become stupid and will not feed. One striking feature is that they can see obstacles so as to avoid them. This is a reflex action of the lower brain; it corresponds to our crossing the street, deep in thought, paying no heed to vehicles or obstacles, yet avoiding them. Our upper brain is engrossed in thought, while our lower brain controls the helm. If the rabbit, or dog, or a rat so treated is shown anything which in health it fears as an enemy, it shows no signs of fright or distress. This is because the upper brain, which interprets what they see, is destroyed. We see the gradually increasing importance of the brain as we ascend from the fish to the dog or ape.

When we apply the microscope, we find the simple structure of the frog's brain is very similar to the early stages of the embryo brain in the dog, and even in man. Our high development is not a sudden creation. It is a gradual evolution from the frog's, stage by stage being gradually improved. Even our wonderful brain-cells appear in simpler forms in the frog. While the frog, like man, has dendrons at the apex of the cell, man seems to be distinguished by having dendrons at the base of the cell also (see Figs. 22 and 24).

One of the important features in brain development is the equipment of the **motor area.**

The frog, as we have seen, can live without it. The rabbit, dog, and similar animals have these areas in slight degree. They are hardly necessary, as most of their actions are so mechanical, and are performed by the lower brain. In fact, these brain centres in the lower animals are more or less run into each other; quite the reverse of man, where they are sharply defined. The ape is intermediate between them and man.

We see this demonstrated in another way. Man, when he is born, owing to the imperfection of his brain can neither stand, walk, nor help himself. The lower mammals are likewise helpless, but not for long, as their lower brains soon develop.

In the case of the chicken the brain, though rudimentary, is sufficient at birth to render the animal independent of help.

A rabbit is quite unaffected by removing its motor area.

A dog is at first paralysed, but soon becomes

quite natural. An ape takes longer to recover from paralysis, and in addition loses all the more delicate movements of its fingers.

These and other experiments show us that all **skilled movements** are due to the cortical cells in the motor areas, while the ordinary mechanical movements of life can be managed by the lower brain.

Another interesting feature about the motor areas is that the size of the area is in proportion to the execution and skill of the parts supplied. Thus the area for the arm is larger than that for the trunk. The areas for the hand, the eyes, and the mouth are proportionately larger than the other motor centres. This is because of the extra skill demanding more motor cells.

It is a remarkable fact that we can obtain complete paralysis by dividing the sensory nerves, leaving the motor areas intact. Thus if we cut the sensory nerves of the arm, that arm is paralysed though its motor nerves are perfect. This proves that the motor cells only act in response to stimuli from the sensory nerves. It is also known that the sensory nerve-fibres of the brain receive their insulating sheaths before the motor fibres are likewise insulated. The motor fibres would be useless until they received the stimuli, and the fibres, as previously stated, are inactive until the sheath is developed. The movement of a limb is complex. It requires the harmony of many muscles. If we bend an arm, some muscles bend, while others which naturally stretch the arm out are called upon to relax.

In **sclerosis** there are little fibrous patches dotted about the spinal cord, which interrupt some of the fibres or nerve currents. The result is irregular movements, reeling or jerking of legs or arms, so that the patient has no control, or power, to guide his actions.

Any interference with the brain cells affects, more or less, every movement or function of the body, and is a key to explain many of these conditions. As a proof of the influence of sensation over the motor nerves, it is observed that if an electric current is applied to a dog's brain, too weak to cause a movement of the paw, if the paw be stroked the extra stimulus to the skin produces movement. This explains how people receive strength by rubbing weak or paralysed limbs, and it is a scientific explanation of **massage.**

Another part of the brain gives no result on the application of electricity.

This is the **pre-frontal.** This portion of the brain may be described as **disconnected with the outer world.** It reaches its highest development in man. It is connected by fibres, which we call **association fibres,** with all the other parts of the brain. It acts as Consultant, Judge, or Commander. It cannot observe, hear, or feel, but receives reports from these brain centres. It is, like every other mass of brain cells, capable of Education and training. If an observation be conveyed correctly to it, correct inferences are drawn; but if the observations be incorrect, the fore-brain arrives at a wrong conclusion. These remarks can be enlarged and applied to our daily

lives, and demonstrate the immeasurable importance of correctness in detail.

In early years the attention should be rivetted to obtain accuracy and truth in everything.

Imbeciles and many **criminals** are found to be structurally deficient in this region. When dogs or monkeys have this portion removed, they become sullen, morose, and vicious. This throws light on the machinery of the criminal's brain, and affects the question of his **responsibility.**

The fibres going to the pre-frontal are the last to receive their insulating sheaths. They do not develop till late in youth or manhood. Some do not appear to be developed even then. This is the true explanation of want of wisdom and impulse in youth. By experience, we do not expect to find old heads on young shoulders. It opens up the great question of legal and moral responsibility in the young.

The male sex are legally not responsible for many of their actions under the age of twenty-one. It would be well if their other legal responsibilities in morals were on a different basis under the age of twenty-one. Worst of all is the iniquity and cruelty which is inflicted by imposing full legal responsibility on the weaker sex over the age of sixteen or eighteen, when they are but children.

CHAPTER XVIII.

BRAIN CENTRES OF ACTION.

From the description in preceding chapters, it is evident that there are six centres of action.

There are the **Sympathetic** centres, which attend to the functions of the vital organs of the body.

In the **spinal cord** there are many centres connected with the muscles of the limbs.

In the **Medulla** there are centres connected with the heart, lungs, and other vital organs.

In the **Lower brain** there are centres connected with the muscles of the whole body.

Finally there are the two systems of **Cortical centres,** the motor and the frontal. These are highly developed on the surface of the brain, and direct and control all the other centres. They give the word of command to act to the lower centres. To understand clearly, let us take the management of a large ship. The captain on the bridge represents the fore-brain; he receives observations from the pilot or the watch, who represent the sensory centres. The captain gives his orders to the chief officer, who represents the cortical motor centre on the brain surface. The chief officer speaks down the tube or rings the bell to the engineer; the engineer representing the nerve-roots or centres in the lower brain which perform the movements.

All subsidiary movements performed among the machinery correspond to the actions of the lower nerve centres.

A point to remember is that the higher brain centres cannot perform, they only originate the idea. If these higher centres fail, paralysis follows. We may illustrate the complexity of brain action in another and wider method.

Take the case of a frontier war in India. The Prime Minister or Indian Secretary corresponds to the pre-frontal. The news from India is equivalent to the auditory and optic sensory impressions which the Premier receives and analyses. Having decided on a plan, he telegraphs for certain action to be performed. The Viceroy of India, who receives the order, is the motor centre on the brain surface. He can do nothing individually, any more than the motor cell; but he wires to the generals, who correspond to the motor nerve-roots, and they set the battalions into activity through their colonels and captains, who correspond to the spinal nerve-roots. The fighting battalions correspond to the muscles, and the scouts to the sensory organs in the skin, eye, ear, and nose.

One may have a good Premier or a feeble one, sometimes hesitating and sometimes rash. Such also occurs in our fore-brains, according to their education, power, and development.

If the fore-brain suffers from **fatigue** it is impaired.

Worry produces the same effect on the whole brain. It disorganises the machinery.

Shock is still worse, for it **paralyses the brain,** and if severe will produce temporary unconscious-

ness, as when a person swoons on the receipt of bad news; while many are speechless for a time.

Worry or excitement will cause irregular nerve action. We call it **confusion of ideas** or **nervosity.** The optic brain centres throw up a series of depressing mental photographs, exaggerating existing trouble. This continues to depress the cells in the fore-brain, resulting in complete failure to judge aright or analyse correctly.

It is at these times that men in responsible positions make mistakes resulting in disaster. Instances of these are common, from the overworked railway signalman causing a collision to the Spanish admiral who rushes his fleet to certain death.

We ourselves daily commit errors of judgment, and it is at these times that the advice of a third party is so valuable. The advice sought is from one whose brain is calm and clear, and capable of seeing everything in the proper light.

Slight annoyances are likely to grow into quarrels in this way. For by brooding over them brain fatigue occurs. Then the imagination sees exaggerated views, until spite and hatred and kindred passions exhaust the fore-brain, and misguided actions result. The stronger the quarrel grows, the weaker the finer perceptions become. It is at these times that cruel things are said, and violent acts, often murder, perpetrated. When the storm is over one sees that it has been a good deal of fancy. A wise brain would have passed the matter over, foreseeing evil by pursuing the subject.

To take a pleasanter type of energy, one finds that the brains of **Orators** are well developed in the

left temple. This is because they are strong in two brain centres which represent—

1. Word memory, by which they obtain a great flow of language; and

2. Speech, by which they convey their ideas with facility.

They also have by education a large selection of brain photographs or mental pictures. This gives fertile imagination or **ideation.**

A Barrister requires all these brain centres. He sees his client's case before him as a picture, and he describes what he sees. If he has powers of oratory he may win the jury very easily where another might fail.

The Judge has a different duty. He is not biassed. He seeks for truth only. With careful analysis his fore-brain views both aspects of the case, and he defines what he sees to the jury.

This is the most fitting place to explain common mental qualities.

Memory is, according to Bain, "a renewed feeling which occupies the same place and in the same manner as the original feeling." Thus without scientific knowledge he spoke the fact truly.

Time is needed for registration. One must have the **power to receive** and the **power to recall.**

Experience is associated with memory. It is the registration of past visions or past events.

Knowledge is the result of comparing and finding out similarities and differences.

Instruction and **Education** consist in the power of receiving and retaining knowledge.

Common sense is the exercise of the judgment

involving a comparison of ideas based on experience. It is the immediate response of the brain to any question depending on previous culture.

Will or will power is the manifestation of the brain force of the individual, the mould or cast of him. He wills to be selfish or he wills to do what is right. But there is more involved, he may be a victim to heredity or surroundings.

Duty and **self-sacrifice** are the highest intellectual faculties. They are due to sympathy with others.

There are mental qualities which are but **Animal Instincts.** Such are **Love, Hatred, Spite, Jealousy,** and similar qualities.

In man, intelligence makes love more lasting and wider than in lower animals.

An over-indulgent parent allows the animal instinct to prevail over the intellectual control, to the injury of the child's mental development.

The other instincts have to do with self-preservation. In some of us the instinct is too strong, and then selfishness prevails even unto cruelty.

The higher the intellect the more these are under control.

As a proof of the stamping of brain photographs or mental pictures, we have the opposite condition in those who are **blind from birth** or infancy. They have no mental pictures. But they are compensated partly by extra development of hearing, smell, and touch.

People who become blind late in life are already educated, but the early blind have no ideas from visual images.

The blind man whom Christ healed only knew men as obstructions like posts, and when sight came, described them as "like trees walking." He only distinguished them by the sense of touch.

Sleep is the natural rest of the brain. It occurs in plants as well. It is due to fatigue of the cells and failure of energy. It is increased by the want of oxygen or by the accumulation of waste material in the blood. After meals we are sleepy, because the blood has left the brain for the abdomen. In anæmia the brain is badly supplied with blood, so the person is always tired or sleepy.

In **Dreaming** the brain is working irregularly, due to locally congested areas. The visual pictures are uncontrolled. If the brain is more affected the motor centres become active, and we have sleep-walking.

In **Day dreaming** a similar process goes on because the fore-brain is inactive, and there is no attention to one's surroundings. Agreeable sights and sounds please us and make us feel well. This stands to reason. The opposite distresses us, and causes melancholia and irritability.

Melancholia or black bile may also be due to faulty action of various necessary functions, causing poisons to accumulate in the system which are depressing. Will power may fight against it, but the victory is uncertain. When depressed and ill, we seek rest and change to bring back this feeling of comfort and peace.

Euthanasia or **mental well-being** is what we must all strive for. The body in health, and the

mind at peace. Unrest wears out the strongest of brains. *Mens sana in corpore sano.*

The most desirable state is the peace which the world cannot give, which "passeth understanding."

CHAPTER XIX.

SELF CONTROL.

We may liken human life to a tree or plant. First the quickened seed, then the sprout, the stem and branches, the fruit, and finally decay and death.

Just as the sprout may develop into a strong, vigorous tree, so the new-born babe may have in it all the elements of a powerful and noble life.

But the sprout may be that of a thorn or wild briar, and, alas! so may the innocent babe be a victim of inheritance, "a vessel fitted for destruction." The die is cast, yet we may be able to fight cruel fate, and by pruning and grafting we may improve the stock.

The babe when born requires a most careful oversight, and in infancy and youth tender loving care. It is a case of watching the growth, bending the crooked straight while it is supple, training, and grafting. Though faculties appear in rotation at certain periods, yet they exist in the undeveloped brain from the beginning, just as the buds in plants and trees lie dormant under the bark, ready to burst forth at the proper season.

Some branches grow crooked, some come at the wrong time and place, and so sap the nourishment of the main stem. These must be trained or cut out.

So with youth wrong desires and impulses

appear, requiring guidance or suppression. It may be like an ill-nourished stunted tree, that few good qualities appear with little chance of improvement. Just as one person is colour blind, so there are in some deficiencies in the moral sense, which none can repair. These are hopeless from the beginning. These feed the prison and asylum, or live as idle spendthrifts, burdensome to their friends, and always sinking lower.

But if we take the average youth of both sexes, there is the greatest scope for training and pruning.

Educating them aright on principles here laid down; we stock their minds with correct ideas on wholesome subjects. This knowledge is for reference as a guide through life. Hence the importance of directing the judgment, will power, and self control.

Until the age of ten or twelve there is no moral faculty in a healthy child. It has not been required. There has been innocent childhood and purity. Unfortunately there are many abnormal variations which cause much anxiety. In early youth the passions develop, both good and bad, and ideation is strong.

It is at this period that with care and wisdom we can direct them to what is high, noble, and virtuous. But, alas! if we miss our opportunity they may occupy an inferior position among their fellow beings.

Self control or the **power of inhibition** or restraint is a progressive faculty from childhood. It is the highest mental quality which distinguishes man from beast, or the noble from the degenerate.

It means the conquering of self and selfish desires. **Selfishness** is the worst of sins, because it is the cruellest, and opens the door to any sin.

Take the case of two starving men; the one suffers, and the other steals because he has no inhibitory power. In daily life we see selfish men or women satiated in luxury, but denying their children of necessities. There is always a desire to gratify the animal instincts. One person knows that it is morally wrong, and inhibits the desire. Another knows equally that it is wrong, but has no will power or self restraint.

The first is of higher mental development, though the latter may be more educated and intellectual. Bright intellect is quite apart from wisdom and high moral faculties.

Genius often goes with a mental instability. Genius is an excessive development of one faculty, and too often at the expense of others. Such a brain frequently breaks down in the most erratic manner, and often has insane antecedents. While aiming at high mental culture we are building a pinnacle, and much depends on the breadth and firmness of our foundation.

Habit is the result of constant repetition of certain actions. The brain grows to the manner of thought habitually exercised, and habit becomes hereditary. We see this in drink craving, or the type of character, or handwriting, or mannerisms passing from parent to child. It is unnecessary to remind anyone of the domineering influence of bad habits, but it is important to insist on the cultivation of the will and self control, to avoid the

circumstances which lead downwards, both for our own sakes and for our progeny.

It is possible for the beautifully cultivated rose and chrysanthemum if neglected to revert to the original wild briar and Michaelmas daisy. This is a law of nature which we call **Reversion of Type.** It applies to us if we are negligent, hence the importance of always being clothed in true spiritual armour and ready for action.

CHAPTER XX.

ALCOHOL.

THERE are two reasons for abstaining,

Physiological and **Social.**

I argue here on the former, and if correct, the social reasons obtain also. If it is wrong for the individual it is wrong for the mass. It has been said that wine is the milk of old age, and it does benefit the feeble heart and weak digestion. It may be of use in convalescence, but there are many superior methods, and it is a dangerous treatment. After long illness, the brain shares the bodily weakness. It is a slight matter to be unable to walk, whereas brain debility means weak will, vacillation, irritability, and nervosity. Very often the moral nature is changed. Alcohol is a powerful **brain poison,** hence its danger when administered to a weakened brain.

The continuous use of alcohol causes thickening and **disease** of the delicate **blood-vessels** which nourish the brain cells, causing the degeneration and softening of the latter.

Brain softening occurs in persistent drinkers, not sufficient to incapacitate them, but enough to annoy their friends. They are silly, uncertain in

temper or action, always untruthful, and frequently subject to delusions.

Alcohol also attacks the larger vessels. The arteries thicken, become brittle, and are liable to rupture, as in **apoplexy.** It also destroys the liver and kidneys. In addition to the changes just described, there is a large growth of spurious fibrous tissue, which destroys these organs, and causes the hardening which we call **Cirrhosis.**

Small quantities of alcohol act as a **stimulant.** They paralyse the sympathetic nerves, and the small blood-vessels dilate. With this increased blood-supply, the nerve-cells show more activity. There is more vigour, more action, and talkativeness. *In vino veritas.* The same condition occurs in slight mania. We have already drunk too much.

The **second stage** follows. The dilated blood-vessels cause slowing of the blood current, due to widening of the stream. The brain-cells now do not get nourishment quick enough, and the waste material is likewise removed too slowly. The former cause produces fatigue, and the latter poisoning. The result is drowsiness, inability to work, and instability of movement. All the brain centres are slightly paralysed. When the alcohol is administered more freely, then it attacks the medulla or life centre, and we get deep unconsciousness, difficulty of breathing, and heart failure. While the first stage shows temporary increased activity, the poison from the first **acts on the fore-brain.**

The result is impairment of judgment and destruction of self control. It is now that a man

is foolish, and easily led into a bad bargain, and occasionally performs some regrettable action, to the disgrace of himself and his family. The paralysing action works backwards through the mid-brain or combatant force. The fore-brain or commander being overthrown, the army is at the mercy of the enemy. Speech becomes thick, the hand unsteady, and the gait reeling; drowsiness and coma follow.

Chloroform acts in a similar manner, and chloral drinking is a cheap way of getting drunk.

All these are poisons specially for the brain cells. Each poison attacks special tissues.

Strychnine attacks the spinal cord.

Morphia and **Opium** the sensory cells of the brain.

Prussic acid the heart, but only through the important nerve which has endings in the stomach —the pneumogastric.

Such is a brief *résumé* of the physiological action of alcohol. When we come to the lower orders we see a terrible picture. The loss of self control in low-typed minds lets loose all the animal propensities. Look at the murders and cruelties, the miserable homes, the unhappy faces of those who ought to be bright with love and affection.

Consider the absence of all natural feeling, and the degrading loss of self respect. Then we realise the **Social Aspect** of the question, and it is a serious matter to decide our responsibility.

CHAPTER XXI.

MARRIAGE AND PROGENY.

It is not difficult to advise, but there are few willing to be guided in matrimony. Our **offspring** are **helpless victims,** as we were and are. The child is but a chip off the old block. You don't get mahogany chips off a deal board, nor do you gather figs off thistles. To take an extreme example, it is barely possible for the children of criminals to be capable of good. Their natures are saturated with evil, and such ground is too stony to yield any fruit, unless the surroundings are completely changed. We are conceived in sin. Our parents' vices and weaknesses as well as their virtues pass down to us. They develop at certain stages or periods. This fact ought to place us in a position of deep humility. The old-fashioned idea that parents are perfect and children far beneath them is an error. It is an inheritance of the old patriarchal idea.

While some emphasise the text "Children, obey your parents," they are apt to neglect the precept "Parents, provoke not your children to wrath." But fortunately what is good in parents also descends to the offspring. This is a great encouragement to improve ourselves for the sake of

our progeny. The more vigorous the mental power, the more healthy the offspring will be. As we see faults arise in our children we should carefully suppress them. They are but the reflections from ourselves. We should work on the principle of **letting in the light,** rather than baling out the darkness. As children inherit failings from both sides, much depends on a suitable marriage. If there be any hereditary weakness it is certain to be transmitted.

Constitutions or **Temperaments** ought to be studied in brief by all. There is hardly a limit to the number, but the chief are—

The nervous.

The bilious.

The sanguine.

The lymphatic.

The mixtures and variations of these are without limit.

The **Nervous temperaments** are mentally impulsive and excitable, sensitive, irresolute, but precise and persistent. They have great power of endurance; liable to go beyond their powers. Intellectually fertile. Most genii and reformers and leaders in literature and science are neurotics. Physically they are inclined to be fair, and of spare form and finely cut features.

The **Bilious** are dark, square, broad, and thick set. Mentally they are serious, cool in business, preferring profitable pursuits to the intellectual. Not very willing to forgive, apt to be spiteful. Happy in accumulating wealth and caring for the welfare of their families.

The **Sanguine** are ruddy and florid, blue eyed, square set, and broad in build. They are impulsive, cheerful, and hopeful. Emotional and energetic, but not enduring. Just as happy over little things as over big pursuits. Firm and outspoken. Too superficial to be well educated, and too happy-go-lucky to be disagreeable.

The **Lymphatic** are fair, usually brown eyes, fleshy, and heavy in build. Mentally slow and careful, thoughtful in arriving at conclusions, ready to forgive; very plodding, but never brilliant or active. Such people avoid exercise, and enjoy self indulgence.

If two people of **nervous temperaments unite** in marriage, the children will be more nervous and unstable. Whereas if a neurotic person with many weaknesses were allied to one of **lymphatic** temperament, the fleshy laziness in the latter would balance the excitable nerves of the former, and the result would be satisfactory. Also their lives would be happier. Two neurotics are like a flint and a steel with sparks always flying, whereas the surplus energy of the neurotic disappears in the lymphatic, like a weight in a quicksand, leaving no impression.

The **children of nervous heredity** may develop fits, bad teeth, paralysis, St. Vitus' dance, mental disease, eccentricities, or criminal instincts. If we can anticipate these evils, we sometimes may prevent them.

This black list does not hang over every neurotic child. Many such children are born to be public benefactors. Most of the genius of this world, the philanthropy, the industry, the inventions, and dis-

coveries, are the outcome of the active, restless, neurotic brain.

A common trouble with **neurotic children** is that they turn out too good. They develop an extreme sensitiveness about religion. Such a child passes through agony, doubting every action, or they may become selfish and bigoted, making fine distinctions. Their way alone is right. They may become followers of one man, and hold religious services themselves, anxious to convert the world, though they are young and inexperienced. They have no anxieties about the future for themselves.

Yet in their private lives they are often secretive, unjust, and unreliable. They do not realise that religion is to be a daily and hourly warfare. Such religious excitement should be strongly but gently discouraged. It takes very little to turn them, and they usually go astray at any moment.

While the nervous temperaments fill the prisons and asylums from misdirected energy and breakdown, the workhouse and prison are supplied from the lymphatic and phlegmatic who won't work, preferring petty crime. In the respectable walk of life you find these always on the verge of bankruptcy, yet not concerned or distressed with the fate hanging over their families.

The sanguine are always happy-go-lucky, always expecting a fortune. They are very unstable and disappointing.

Cousins should never marry. **Consanguinity of marriage** is fertile of mental disease and other defects in the children. Intermarriage is very common among Friends and Jews, yet we find

brilliant intellects among both. The danger is greater where the cousins are of neurotic type.

Marriage should be discouraged where there is marked tendency to consumption. There is great liability to spinal and joint and gland diseases. The brains of tubercular people are frequently unstable, though brilliant in execution.

Having got **the offspring,** what are we to do with them? Attention to all their animal wants is the kindest action we can do in their early months and years. Build up their bodies, **let their nervous systems lie fallow.** Abundance of milk and farinaceous food in early years, not much animal food, and the less tea and coffee the better.

Badly fed children get nervous, irritable, and timid. The **food** may be in abundance, but **unsuitable** or too stimulating. They are liable to be stunted in body, and develop very large heads. They get **water on the brain.** Some die, some pull through, but are always excitable, and very active. Such children should at once be cut off all animal food, and the body fattened up with milk and starchy diet, especially porridge.

Parents are apt to be overbearing with their children when the latter are wilful or stubborn. We may safely say that it is all the parents' fault. In the first place, the child's fault or weakness is inherited. Probably some physical cause, or some health derangement aggravates it; and finally the parent strongly resents any show of temper or irritability on the part of the child. The parent ought to meet the child more than halfway with sympathy and patience. It is a mistake to domineer

over a child. Neurotic children strongly rebel, while lethargic children grow careless. It is possible but difficult, and always painful, to crush the evil out of a child; the good nature of a child gets a great deal bruised also.

It is a mistake to make too many laws, for where there is no law there is no sin. It is better to guide by example as well as precept. There is more moral force in ruling by **the Unwritten Law.** The parental bond may be strongly woven, but the knot is tied by either fear or love. It is the parents who are responsible. They must smother their daily worries to present a cheerful and loving face to their children. It is no use fighting a fractious, self-willed child. Its brain-cells want cleaning and repairing, for which purpose it must have rest and change. Dame Nature will manage the detail, if we manage our own self control and rule in love. It will be joy to that poor child to find some one to lean upon. It longs for a peaceful rest upon its parent's bosom. It is useless to endeavour to distract with amusement the poor mind in such a state of tension. The gentle touch of the loving hand will both soothe and cure where punishments and arguments not only fail but aggravate.

How preferable is the knot of love! It is like the fine silk—firm, but unyielding and soft; whereas the ruling of law and punishment resembles the rough, chafing, hempen cord, which causes much friction, and is less enduring.

Unreasonable punishment, due to the passion of the parent, is depraved and criminal. Few can estimate how sensitive some children are, and how

their tender natures fret over injustice, even though they forgive. One sees this among the poor. The crushing and bullying processes pass from parent to child, and from strong to weak. There is very little domestic happiness or affection.

Life is sowing and reaping, and it is worth while to sow wisely. A happy childhood is bliss, and depends on the loving patience of the seniors.

A happy old age is greater bliss, depending on the loyalty of the juniors, but it is the reflection of the early life and surroundings of the latter.

In **education** it is wrong to force a nervous, irritable child when lessons become a toil. Rather let a child be a dunce, until you can discover its habit of thought, when you may be able to develop some hidden talent.

The period of development of **puberty** is always anxious. The character becomes very marked. The small germ of evil may bud forth into great evil, never to be recovered from. But if there has been a healthy, happy childhood, it blossoms out into a boyhood or maidenhood of much joyful promise, courage, and determination to do what is right.

From puberty to **adolescence,** the parents should be close companions of their children, sharing their confidence, pleasures, and troubles. Care should be taken to select good influences in their business or professional relations, that their characters may be well formed. It would be more desirable to live in poverty than to be trained in business houses where commercial honesty does not obtain. It is amazing, the low *morale* in business that even some religious people practise.

Arrived at the period of adolescence, they are fully fledged, and Nature dictates that they separate from us, and we can only watch them with hope, prayer, and trust, sailing their barques over the Ocean of Life.

CHAPTER XXII.

RELIGION.

Some may feel that a doctor is not the best expert in religion. In truth he can advise very well on this subject. Not only has he cold materialism at his finger tips, but his vocation at every point arouses his tender sympathy, while his intellectual power views from a different standpoint the warfare of sects, and he is able to sort out the good and leave the bad.

Those who live among the sick and sorrowing see life from a different aspect to those who exist for pleasure and gain.

Our education makes us public slaves, self-denying but not servile. The doctor toils without regard to personal gain or fatigue, and from a business point of view always against himself. The intimate knowledge which he gains of human nature and his understanding of the mind, give him authority on the matter of religion.

There are only two kinds of religion, **true** and **false.**

Atheism is not a religion at all. It is a barren soil in which nothing will grow. If you look to the atheist for fruit you only find thistles. It is usually the outcome of selfishness and conceit, or ignorance.

The **Agnostic** suffers from paralysis; he knows nothing, and cares for nothing. He may believe in

a First Cause, but not in the Originator of the First Cause. Discussion would be futile, as we have no common ground.

I will pass on to the Christian religion, of which there are two varieties—true and false.

True Religion

we find in the Bible, nothing added and nothing taken away. No special selection, everything in one solid mass, leading man from sin and misery to worship the Eternal Father.

False Religion

is man's contorted view of the true. He places a decorated scaffolding outside, and people mistake the scaffolding for the temple itself. The one is temporary and temporal, while the true is Eternal and Spiritual.

Religion contains **essentials** which are few, and **accessories** which are many.

Religion is a matter of fact, but it is usually treated as a matter of opinion and sentiment; yet there are twelve gates leading into the New Jerusalem, which allow for modified types, according to our upbringing and our opportunities.

We cannot all be burning and shining lights; some of us have only feeble oil lamps. We must, however, act up to our lights, always striving for a purer development of the Spiritual nature.

The Spirit of God approaches a man by two ways,—by the Senses and by the Intellect; in other words, by the mid-brain or the fore-brain.

In olden times God made Himself manifest to His chosen people by signs and symbols, which were types of what was to follow in the latter days; thus, incense as an emblem of prayer, blood as a type of atonement, and so on. The Old Testament is full of figures of speech, which are of deep interest to the student, but like a foreign language to those who do not understand.

In those days God appealed to the people by the senses of sight and hearing, and by exacting certain actions to indicate that they loved Him.

But when the earth was shaken, and the veil of the temple rent in twain, all earthly symbols were to cease; for Christ rose from the dead, and became the direct bond or tie betwixt God and man. There are still many minds which receive comfort and support from external symbols.

The higher spiritual religion appeals to the more intellectual or pre-frontal brain. This religion recognises no authority between God and man. It is a perfect trust and confidence in the Maker.

Children must be taught the simple truths of the Bible. The Sermon on the Mount is a grand basis to build on.

Few children are impressed with the importance of truth.

People do not realise that language is not confined to speech, but also to symbols. A person may tell a lie without uttering speech, but by practising deception. Religion is not a Sunday garment, but ought to be carried into our business lives.

Religion is not a creed, it is a life.

There appears to be an art in serving God with

the left hand, and mammon with the right. These people not only disgrace religion, but also discourage the young from drinking at the Fountain of Living Water.

While in no way denying the Spiritual nature of man, I will give the physiological explanation of **Spiritual conversion,** in order to help those who doubt or ridicule religion.

No person can be converted without previous Biblical knowledge. The brain is stored with mental pictures of Biblical scenes, and the fore-brain by analysis builds up ideas and principles of morality, and avoidance of evil. Before conversion a person is reminded of the misery and uncertainty of his situation, and the preacher draws mental pictures of still greater horrors. The impression on the individual leads to a halt. He is in mental pain and agony from the brain photographs which are being roused or recalled. In response to the preacher, who stimulates the optic centres by describing more hopeful scenes, the individual resolves to make a complete change. His fore-brain is stimulated to self control, and to attention to individual actions on higher principles. It is on the same principle as a person approaching a precipice sees the danger, and turns back.

There is also the **Social aspect of conversion.** One sees the misery to one's self and others as the result of evil actions, and the fore-brain as judge or commander directs the opposite course, in order to promote the welfare of the community. Many do not realise that conversion is the mere germination of the seed. They say if you are converted

you are saved, but though you may be in the life-boat you are not yet in harbour.

The tender shoot requires protection, care, and nourishment to insure any growth, otherwise the seed dies at once. This is the cause of the large infant mortality in religious revivals.

The normal condition is for each child to receive good Biblical training, and healthy religious instruction.

As the brain develops, the child grows spiritually. The soil is good, the seed sprouts early, and grows vigorously, and brings forth fruit in proportion to the intellectual capacity. Many **fall away** from religious instruction, and the chief **causes** are— .

1st.—The religion is heavy and distasteful, or shallow, producing mental nausea.

2nd.—Mental defect, or absence of moral sense of responsibility.

3rd.—Selfishness, preferring pleasure in place of duty.

There is another stumbling-block to those who are anxious on religious questions. Many religious professors, and sometimes those in authority, show their **old faults**, not only without remorse, but even justifying themselves. These self-righteous, self-opinionated individuals are the most irritating people we meet. They have no charity, are unkind to their neighbours, and of low *morale*. Their religion is but a veneer, with no effect on their past life and heredity. Their armour is not thick enough, its quality is poor, and the natural man shows through it.

Many earnest individuals are still victims of evil

habits. Self control is gone, the fore-brain is weak. They are like plants in bad soil, showing much blight and little blossom. Let them console themselves that though the vitality be poor, still they live.

Literature.

It is astounding to see the literature that many religious people consume, and more amazing that they seek to justify it.

Children should be carefully guarded, for books furnish them with brain pictures, and stir up mental photographs. If they be good, the child grows in favour, like Daniel on his plain wholesome pulse. But if evil, even if only moderately so, they are sufficiently suggestive to start a line of thought which may develop into unconquerable habits.

By nature most of us are selfish and evil, and it is dangerous to foster the taste, though by intellect or pre-frontal we ought to choose good. The whole reason why cheap and bad literature prevails is because it suits the tastes of so many. No one can predict who is strong and who is weak, or who is likely to fall. "Lead us not into evil, and deliver us from temptation," is the most necessary prayer for each of us.

On scientific grounds it is wrong for **the young to know of evil.** Their brains are not developed sufficiently. Their impulsive natures may yield, and their inhibitory power or self control ought not to be overstrained.

If you wished to train a youth to abstinence, you

would not give him sips of alcohol. That would provoke the taste in spite of all homilies against it.

The same rule applies to "snacks" of immorality neatly folded up in fashionable literature.

If we wish to study electricity, we do not select a text-book on natural history. If we desire to study religion, the Bible is our only text-book. While spiritual life is a gift for every man, in many the seed never germinates. In some the soil is too barren by reason of mental disease, or absence of healthy brain structure. In others it is choked by bad heredity, or bad surroundings. Hence our grave responsibility to others. We must remember that spiritual life is not an external halo, which we can divest at will, or exhibit to some and hide from others. It is part of our brain texture, of living brain-cells; and more, it is the true "Ego" which lives for ever.

CHAPTER XXIII.

SUGGESTION.

In the days of our training we yield readily to command. When we grow up and are conscious of our own strength, we are apt to resent this form of government. Suggestion is, however, a subtle modification of command. It is slow of operation, but certain. It twines round the mind and soul like ivy or mistletoe round the oak.

Hence the importance of suggestion, a powerful factor for good, a terrible weapon for evil.

It is by suggestion, that we are influenced from the pulpit, or by the oratory of the politician, and by the man of good or evil mind. We are also subject to **self-suggestion.**

The fiendish theatrical placards, and the depraved literature of modern novels and "penny dreadfuls," are social dangers in the suggestion of evil and the growth of crime. Suggestion of this kind easily affects the weak-minded and the unstable, even bringing boys to the gallows.

There should be **State control** over these matters, with a view to the prevention of crime and the **protection of the weak.**

Suggestion **acts on the pre-frontal** lobes. It influences the commandant of the army, hence its power over the individual.

It acts on his will power or self control.

It is the agent in hypnotism. As the name implies, the brain is lulled to sleep before the operator can control his subject.

HYPNOTISM

may be used with advantage to the cure of drunkards, and some forms of hysteria, melancholia, or mania. It is a curious phenomenon, and at present there is no absolute knowledge of its condition.

The most recent theory about hypnotism is that we possess two layers of consciousness, an upper and a lower. We live and move in this upper layer, and if we suffer mentally or morally it is due to decay or defects in this upper layer.

In the hypnotic state our lower layer of consciousness is called into force or action. It is in every way superior in quality to the upper layer, hence the pity we cannot always use it.

When the drunkard breaks down in his upper layer, the hypnotist brings in some of the lower layer into the gap, and self control and virtue take the place of mental instability.

I do not think this theory will last. It is indeed hard for the majority of mankind to have this superior secondary consciousness lying idle. Moreover, under hypnosis it is possible to suggest crime, though some dispute this.

My own theory of hypnotism is that it is a sleep or mild paralysis of the brain or of self-consciousness.

In order to induce this condition, one must first **paralyse the fore-brain.** When the fore-brain is

dead to the outer world, then you can drive ideas or sensory impressions into the brain.

The first process is to fatigue the eyes by fixing the gaze till drowsiness supervenes. **Attention** to outward objects is **gone,** and the individual is sleepy.

The **will power** and judgment are **gone,** and the subject is open to suggestion.

You may influence a person to give up an evil habit. On waking, the influence continues in some cases, but by no means in all.

Our natures or dispositions may be altered in the same way by other causes. Take as an instance, an equestrian may meet with an accident, and always abhors horse-riding afterwards. He knows it to be foolish, and desires to ride, but an inner aversion prevents him doing so. Here there is a constitutional change of mind which resembles that of hypnosis.

Each of us has had experiences in life like this, and the two cases are similar, though difficult to explain. We call this fear "shock to the nerves." There is something more, for there is a complete change in the constitution. It resembles the dislike the hypnotic subject gets to drink or other evils.

In hypnosis you can practise deception, and make a person eat soap and fancy it is sugar.

In a more advanced stage you affect the motor and sensory centres, so as to be able to stiffen the limbs in various ways; while if carried further, profound coma will result.

The whole brain cortex is then paralysed, and it appears to have depressing action on the heart and breathing centres, judging from the public shows.

So that hypnotism acts on the brain from before backwards, or from the highest centre gradually to the lower ones.

It follows the same track as chloroform and alcohol.

Fortunately no one can be hypnotised against his will.

Many persons are open to a modified hypnotism in a slight degree, without knowing it.

Thus sympathy with those in sorrow or pain, soothing, dreamy music, or any monotony, all aid in allaying the attention to external objects or to one's self, and place the subject open to suggestion. It is a powerful factor in the more vivid methods of worship, and that accounts both for the successes with those hard of heart, and the failures with those who are converted only superficially. The latter form a curious class for study; when hypnotised in their meetings they overflow with religion, and when they wake up outside they return freely to all their worldliness, and often wickedness.

Somnambulism

is allied to hypnotism.

In the forty winks after dinner the fore-brain alone may be asleep. We hear conversation, and know all that is going on, even being able to converse.

In the more advanced stage there is general coma or unconsciousness, while **dreams** and restlessness, even sleep-walking, may occur, because those **special areas** are not in deep healthy coma, but **in confusion,**

possibly local congestion, either from shock disturbing the whole machinery, or poison from erroneous eating or drinking.

There is then a waking state and a sleeping state. Similarly we **all lead two lives.** There is the **public** life in the gaze of our fellow men, and our **private** lives, some of which we would not include if writing an autobiography.

Alcohol, unfortunately, develops a **double personality.** The second personality is either foolish or bad, never wise or good. No man ever made a good business bargain while in drink; while the abominable practice of doing business over a glass of wine injures both mind and body, and is a common cause of cirrhosis of the internal organs.

Louis Stevenson, in his novel 'Dr. Jekyll and Mr. Hyde,' fully portrays double personality—one person leading two lives.

This is an extreme case. Jack the Ripper is probably of this type. While we know him only as a murderer, in his other more private life he might be a real pious Christian.

The more pronounced cases of double personality are often associated with epilepsy.

A unique case has for three years been under my care. A young person after influenza had hystero-epilepsy changing into different personalities. In most personalities requiring fresh education, ideas being often misapplied. Thus white would be black, also the patient could write backwards perfectly.

In one state there would be blindness, in another paralysis, in another amiability, in another great irritability. There were about nine sub-stages,

each sub-stage continuous. The patient is now settling down in an abnormal stage, but resembles an ordinary person, though not the original self.

The same in slight degree happens to many of us. We are often surprised how on a particular day we could have been so cross or unreasonable, or our judgment may have been warped, or in some way varied much from our natural self, either for better or for worse.

It illustrates the old saying that there is a good and a bad side to every one.

While our friends notice these mental changes more easily than we do ourselves, it is likewise a reason for tolerance, till the storm is over, to know that it is temporary disease.

There are two chief periods of life when these attacks are more frequent; at the budding forth—from the ages of twelve to sixteen, and at the change—from forty-five to fifty-five. Much care of health is then required, and much patience during the nerve storms.

CHAPTER XXIV.

INSTINCT AND INTELLIGENCE.

It is extremely difficult in many cases to distinguish between these two faculties. It is a popular error to attribute to intelligence the marvellous habits and abilities displayed by bees, ants, birds, beavers and other animals. They have no mind, thought, nor previous education. They are complex machines, displaying a lower form of nerve energy, which we call instinct. These instincts are necessary to enable them to play certain parts in the vast **Economy of Nature.**

No education is required to teach the bee to build the honeycomb, or to make honey. It is a machine furnished with all the apparatus. If intelligence were necessary, then we might educate the ant to make a honeycomb, or the bee to build an anthill. If the bee had intelligence it might learn another trade which would be fatal to the propagation of plants, whose flowers the bee unconsciously fertilises whilst probing for nectar. Similarly among birds; each species constructs a nest on its own type specially adapted to its own requirements.

The study of the animal kingdom reveals remarkable instincts, but I am inclined to believe that it gradually fuses into intelligence.

Though a chicken be artificially hatched and blindfolded, yet it will at once run to the call of a mother hen. This is unquestionably instinct. So is the fear of a hen when its ducklings enter the water. If a hen had intelligence, we could teach it to overcome its dread of water. The same fear of water applies to the cat. When the squirrel lays up its stores for the winter there is no intelligent forethought. It is an instinct stamped by nature, necessary for the survival of the race.

There are in animals many instinctive fears. Young birds show fear the first time they see a bird of prey. But is not their fear of man partly intelligence? Even fish may be tamed to feed from the hand, or to come when called. Is not this more than instinct? What about the parrot that swears at the sight of a sailor, knowing the association of the two factors? Yet the imitative power of a parrot is singularly devoid of intelligence.

The well-known anecdote of the pair of wrens in a Welsh quarry illustrates an intelligence of low degree. When the men rang a bell before blasting, the birds flew away; so the men used to show off the birds to visitors. But intelligence revealed the trick to them, and so they waited for a more certain signal, and would not leave the hole till they saw the workmen run away.

The rook also shows intelligence in distinguishing between a gun and an empty threat with a stick.

Horses show intelligence rather than instinct in many of their actions, being easily educated.

But dogs, by their intercourse with man, reach the highest degree of intelligence, yet **much of apparent intelligence is in reality instinct.** Thus the special abilities of the sheep-dog, the retriever, the setter, are all instinctive. Who could teach a terrier to manage sheep, or a pug to retrieve or point?

We have many instincts though intelligent beings. Many of our animal faculties are instinctive, such as parental affection.

This faculty, through our intelligence, is ennobled. We love our offspring long over the age when they can fight for themselves, while the opposite prevails in the animal kingdom.

Certain **fears** become **instinctive.** Thus a few years ago, when bicycles were rare, there was a dread of them which was more instinctive than intelligent. Now that they are so frequent, the sudden ring of the bell does not cause the same alarm. It is curious to note that dogs recognise the rights of the cyclist, from puppyhood upwards. It is probable that the fear of the cyclist is as much instinctive as the natural fear which birds and wild animals have of man.

CHAPTER XXV.

NERVOSITY

Is an important subject as a matter of encouragement to those afflicted, so that it requires brief mention. It presents various features during the different periods of life.

In infancy and childhood it is a very wearing affliction both to the child and its friends.

It is important to trace any cause such as indigestion or sleeplessness. But as to pure nervosity, what the friends are pleased to call passion or temper, that must be treated differently.

The friends usually keep the ball rolling, no doubt with the best intention. It is important, however, to let the child feel itself absolutely ignored. The storms will blow over sooner, and in time a calm will prevail. The irritable child becomes docile, and the passionate becomes amiable.

The sense of freedom is a safety valve to the misdirected energy.

Nervosity in youth is often associated with a painful self-consciousness, which is quite different from conceit. More often it is a cruel self-humiliation. Occasionally there is much misery from an

over-sensitive conscience, which doubts the integrity of every act.

The cure is in withdrawing the mind from self. Encourage industry. Raise some high ideal and work up to it. One must get interests in other people, and enlarge the sympathies.

Adult nervosity is but a continuation of that which occurs in youth.

But about the age of forty or fifty a nervosity comes to some which is so painful that it is akin to melancholia.

In this form there is a constant inward fear that something dreadful will happen. Argument avails nothing. Rest and change are curative.

Senile nervosity is painful, as it is the evidence of decay in the whole machinery.

It consists more in restlessness, and fidgeting every one who is near.

The proper treatment is to give the sufferers plenty of room and leave them alone. This may be managed diplomatically without wounding feelings. To argue for reasonable conduct only aggravates, and indeed pleases them, as it gives an opportunity to add up grievances.

In all forms of nervosity there are two golden rules:

1. Fresh air and out-of-door exercise in abundance.

2. Plain farinaceous and milk diet. Avoidance of meat, which is too stimulating, and absolute abstinence from alcohol.

The result of foolishness or erroneous treatment

of nervosity in the young or middle-aged, is to warp or destroy the good characteristics, and bring out the unfortunate mental failings, sometimes in very marked degree.

CHAPTER XXVI.

INSANITY—WRECKS.

THIS subject is so much within the sacred domain of the physician, that it would be wrong to pander to any morbid craving of the reader. It is often said that we are all mad. This is certain, that there is **no sharp line dividing the sane from the insane.** There are a great many on the borderland of insanity, yet still able to hold their own in the battle of life, while there are many great intellects who are subject to insane impulses or actions. We must study insanity as a formidable enemy, which may crush any one of us. At no time is self-help and self-control more needed, supported by the aid of others, than in the early stage of mental disease. Even then the enemy may be too powerful.

There are two **causes** of insanity,

Heredity and **Environment.**

We cannot escape the former, but we may evade the latter. Sad to relate, heredity claims some victims whom none can save.

Among **surrounding causes** are grief, long illness or head injury, wasting the brain power; alcoholic and other excesses, damaging the brain-cells.

It is therefore very important carefully to guard and strengthen the weak, until their brain vigour returns. **Alcohol** being a powerful **nerve poison** ought never to be administered in convalescence. It may improve the heart or digestion, but the same may be attained by better methods.

Unfortunately the law gives us no power to restrain those who are ruining themselves and families by alcoholic excess.

The **struggle for existence,** and the **anxiety for to-morrow,** is one of the **chief causes** of insanity among the poorer classes; but those who are clean, thrifty, and temperate among the poor, are seldom visited by the relieving officer representing the County Asylum.

Where strong heredity exists, much advantage may be gained by observing the **Laws of Hygiene.** Plain diet, suitable occupation, and absolute abstinence from the brain poison, alcohol.

Such a weak brain would be ruined on the Stock Exchange, and yet be successful as an architect, farmer, or even engineer.

Where there is heredity it crops out in some form. It may be pleasantly as in genius or talent, or it may be in a nerve disease or melancholia, or passion, conceit, cunning, dissipation or crime.

Marriage should be strongly discouraged when these tendencies exist. Intermarriage is a fertile cause of mental degeneracy.

It is not often that a person becomes suddenly insane. There are **many warnings.** A man's character changes. What is insane in one person may not be insane in another. A man of low type

may be dissipated, gluttonous, or self-indulgent. But if a steady industrious man strays or becomes passionate with his family, or slovenly in his ways, speculates beyond his means, quarrels and interferes all round, his friends say he is an altered man. His habits of life are changed, because his brain-cells are degenerating. He may not go far enough to require asylum treatment, but he becomes a great anxiety to his family and obnoxious to his friends. Worst of all, his condition not being recognised, some action might bring him within the pale of the law. Or in other people there may be a failure in health, possibly from overwork, and a melancholia may occur, very slight at first; or they may fancy people are talking about them, getting up imaginary or exaggerated grievances. In some way or other the friends notice a slight change in manner, affections, or character.

Insanity is too varied in its manifestations to classify easily. But I will briefly describe some of the main varieties.

There is **Amentia,** cases born without mind.

Dementia, cases that lose their mental powers; shipwrecks breaking up.

Passive insanity, melancholia, delusions, general paralysis, monomania.

Active insanity, mania, some epilepsies, and criminal acts.

Amentia

shows structural brain defects from birth. These accidents are usually due to maternal shock or strain, often intemperance of one of the parents.

These usually are placed under care early in life.

Idiots have no power of speech, and present great variety; some with small brains after the ape type, while others have enormous brains.

Imbeciles, with the power of speech, may even have enough brain power to occupy minor positions of daily life. They are always uncertain, often dangerous, and frequently commit criminal acts. This condition may be hereditary or due to intermarriage, but is often caused by faulty nutrition in infancy, or by accidents, such as falls or sunstrokes. The poor brain-cells are damaged before their period of development has arrived. A great deal may be done for these in early years, and in youth, by the wise selection of occupation to avoid overstrain. Unfortunately many families are unaware of the true state, until the afflicted one commits some act which brings the matter forcibly and unpleasantly to a crisis.

Cretins are cases of arrested development. The child is feeble in mind, and at puberty does not blossom out as a normal, vigorous, intelligent youth. But he or she remains in the same condition throughout life; the male cretin like a boy with a cracked high-pitched voice, stunted in growth, and deficient in hair. It is due to the absence of a glandular secretion; that of the thyroid gland in the neck. They may be improved by feeding on this gland. By removing this gland from dogs, they lose all their natural intelligence, and degenerate, resembling the condition of a cretin.

Dementia

is the usual ending of all insanity. The mind decays on account of brain softening. In bad cases the brain is unrecognisable.

It is the natural condition in old age, but not so marked as in disease.

In **Senile dementia** there is aimless restlessness, loss of memory and will power, and talkativeness. Familiar faces are forgotten, and the same questions asked time after time.

The insane dement may sit like a log all day, or talk nonsense and be excitable.

Melancholia

always appeals to our sympathies. It shows many varieties in type and amount. A common idea is the fear of the soul being lost.

Excitable religion is frequently responsible for unsettling unstable minds. Oh for a pure simple religion such as Christ gave, one that comforts and sustains! Not illuminated by fireworks, or decorated by perishable splendour. Many of us outside the asylum walls suffer from melancholia. It falls like a cloud or mist around us, and there is no escape. It is real mental pain, more agonising than physical pain. Those afflicted must seek suitable surroundings, cultivate hope, and avoid stimulants. It is in such cases that parents in despair so frequently destroy their children, and most suicides also are due to this disease.

is more common out of the asylum than in. Delusions are very commonly held by those afflicted.

Kleptomania or **thieving** is a very frequent form. Such patients may steal rubbish, or they may display great art in robbing money or valuables. They exhibit no shame or fear, and they excel in deceit and cunning.

There are some little monomanias which many of us suffer from.

There is the **Folie de toucher**, in which people must touch something. They cannot walk through the streets without touching special paving stones, pieces of paper lying in the road, or gates, or some object in a room. Street boys are often afflicted, striking the fences at intervals, or opening all the gates in a street. Some of those afflicted are compelled in the routine of duty to perform minor acts or fulfil certain ideas; for example, pulling a ring off two or three times before speaking or acting.

Folie de doute is a much more common form, which few of us escape. If we lock a drawer we look at it twice, and then may return, and even then fidget all day lest it be insecure.

The same doubt crops up in many ways.

Illusions are misinterpretations. One sees an object and thinks it something different. A bush on a dark night looks like a highwayman.

Delusions are fanciful imaginations.

In delusions there are no external objects, but mental pictures or sensations suggest the erroneous idea.

Very frequently patients have delusions that they are royal personages or divine beings, or fancy themselves tortured by electricity, or they hear voices speaking to them.

Many ordinary people exhibit delusions, as in affected grandeur, as if their social position and extraction were higher than is the case. It results in snobbism, affectation, and super-affectation.

This is the **monomania of grandeur.**

Chronic intemperance may truly be characterised as a monomania of degeneration.

Other monomanias may exist from want of control of various weaknesses, whereby the habit comes into undue prominence, such as **monomanias of pride, dress,** deception, **suspicion,** and others.

I do not consider it the function of this book to describe all the special mental diseases. I will allude briefly to two.

General Paralysis of the Insane

requires notice as it is increasing so much, and persons may be afflicted with it for years before their friends suspect any trouble. Those afflicted have delusions of grandeur. They are immensely pleased with themselves, and extravagant in all their ideas and methods. Even when helpless and in rags they imagine themselves millionaires. At a later stage there develops inability to speak distinctly. The last stage is ushered in by paralysis and unconsciousness.

A prominent politician some years ago, in the early stage of this disease, not only shook the whole

country with his energy and eloquence, but also became a leader in the House.

Folie Circulaire

is the other disease which may be mentioned without apology.

Those affected go through three periods. First, excitement and excess of good spirits. Second, depression of spirits and stupidity. The third cycle consists of the normal mental condition.

The disease may run a course of months or years, and the changes may be so slight that no ordinary person would suspect insanity. The persons so affected would be only considered peculiar and very troublesome. One of our greatest thinkers and writers of the last half-century affords an instance of this complaint.

Mania

is a convenient term which embraces a large number of active insanities.

It may occur as a violent struggling, which is the result of too much blood on the brain surface;—a series of explosions from the motor centres.

It may in **religious mania** take the form of undue excitement about that special subject, or it may exhibit itself by way of insane impulses, dangerous to those affected and to others.

The **suicidal mania** is very troublesome. The victims are so artful, and so determined to succeed, as often to baffle the closest observation.

Homicidal mania may often occur without any warning. It is frequently associated with epilepsy.

Epileptic mania or **impulsive insanity**

presents many varieties, from the homicide to an ordinary uncontrollable temper. This subject is closely related to crime, and will be more fully discussed in the next chapter.

Sometimes the dangerous assault is preceded by an ordinary epileptic fit, or the man may have been morose for a few days, or the attack may be sudden without any warning. **No responsibility** can be attached to the individual for his action. Sometimes the patient is broken-hearted afterwards, or he may exult in his deed, and again he may know nothing of it.

There can be no question that those who yield to violent temper, and bully, are suffering from this mania in a slight degree.

I once employed a youth from a reformatory who suffered from this insanity. His temper was terrible, and he also had kleptomania. I eventually got him on a farm in Canada, and warned him that he would develop epileptic fits. Two years later he wrote me that I would be pleased to hear that the fits had arrived.

When his temper was violent I occupied him in hard manual labour—digging, sawing, or hammering. This is the best way to treat such **overflow of energy.**

These cases often get apparently cured, but are always liable to recur. The law insists on their

liberty, but the asylum doctor knows that they will either return or commit some terrible deed outside. In the latter case they are sent to Broadmoor to end their days in idleness.

Epilepsy

has many features both in the shape of explosions in the motor cells taking the form of convulsions, called **grand mal,** and also in impulsive actions resulting from delusions. There is a form of epilepsy called **petit mal.** Here there is a momentary unconsciousness or movement, so slight sometimes as hardly to disturb the individual even while walking through the street; yet equally grave, as indicating serious brain disease.

Some epileptics are very untruthful, ungrateful, and in every way unreliable. Some are very liable to see visions, as Mahomed. They may by energy prove remarkable characters, like Napoleon.

Hysterical Epilepsy

is quite of a different type. There is loss of control but no danger.

This is regarded by some as a perversion of the brain or mind; but it is due to the effect on the brain of a deranged sympathetic system.

Some internal organs are out of order, and the sympathetic which controls is thereby complicated.

Self Control

is **the line which divides sanity from insanity.** When it fails, the individual is insane and requires care and protection. If there be a hereditary pre-

disposition, we can do much to overcome it by cultivating self control in the unfortunate victim. The surroundings must be carefully studied; every effort made to strengthen the character. Total abstinence must be insisted upon, as alcohol undermines the brain power. Many a weak brain on the borderland may thus be rescued.

There is also an **Insane Temperament**, just as there is a gouty or rheumatic constitution; thus some when ill have a little gout mixed up, or rheumatism, or scrofula.

Similarly, many ordinary citizens have **a tinge of insanity** in all their thoughts and acts, without actually crossing over the borderland. Such people are uncertain, perhaps irritable or eccentric, mentally unstable. Many are degenerate in natural affection and moral perception. Often unfaithful in business, quarrelsome with their friends, and cruel to their families. Ordinary diseases may influence this type of insanity.

Thus, **in gout**, there is a special type characterised by melancholy, bad temper, and inability to exercise the mind. These are but exaggerations of an ordinary attack of gout.

In rheumatic insanity there is a great tendency to twitching and irregular movements.

Chorea or **St. Vitus' dance** is characterised by spasmodic jerking of muscles, and is always connected with the rheumatic constitution.

Phthisis or **consumption** is well known to have a peculiar symptom called "**spes phthisica.**" The patient, though dying, has always hope of recovery, even to the last hour. There is no mental activity,

but a passive pleasant delusion. This is probably due to the starvation of the brain, caused by tuberculosis. When afflicted with insanity it is in the form of **suspicion**, often making cruel accusations against those who treat them with great affection.

People of tubercular constitution, though not ill, may evince the same character to their friends. They may be sullen, suspicious, and unsociable. Their family are often deeply distressed. If the friends only knew the reason, their grief and disappointment would be consoled. The invalids can no more avoid these mental failings, than prevent coughing.

There is another form of insanity which is very common, but seldom carries one over the borderland. I shall call this the

Folie de regret.

In this form, one is always regretting past actions. It is often associated with religious melancholia. The nervous child or youth doubts every action, whether it be right or wrong. It more commonly affects women, but may just as easily affect the male sex, when over-worked or run down.

This subject is endless, and therefore without apology I will cease detailing types. I trust that the past description will be of great assistance to many who are toiling and struggling often against great odds. The melancholic will now perceive that his suffering is but an extra mantle or overcoat, which if possible he must try to disrobe.

The anxious parent will now know how to deal with the weak-minded child. Between forty and

fifty there is **a change in life,** and during this period people suffer from great mental disturbance, over-anxiety, extreme **timidity** and **nervosity,** a constant fear that something is to happen.

Responsibility.

No insane person is responsible. Insane people are supposed to argue from insane premises, but they often begin on wrong premises. **Their reasoning is insane.** A lunatic lives in **dream-land.** Our dreams sometimes frighten us. They often are horrible, and if the ideas or imaginary acts occurred while awake, we would either be insane or criminal. This is practically the normal state of the lunatic. Many lunatics **hear voices** commanding certain actions. They must obey, even if it be murder. But **a lunatic may even have a motive in a crime.** They may imagine some one has injured them, and they must be avenged. But more of this in the next chapter.

Very often the **first knowledge** of insanity in an individual may be **a crime,** or a crime may usher in an attack of insanity, and then there cannot be responsibility.

Prevention.

The key-note is to cultivate self control. When there is heredity, place the individual in suitable surroundings. Avoid alcohol, all excesses, bad literature, over-work, or positions which entail responsibility or anxiety. Encourage industry, healthy out-of-door exercise, and administer plain vegetable food. Animal diet is too stimulating.

Surround with healthy influences. Work up to an ideal and get the will power into line with proper moral sentiment. Above all things, **do not overdraw the mental banking account,** as bankruptcy is inevitable.

CHAPTER XXVII.

CRIME—WEEDS.

CRIME may be divided into **illegal** and **immoral.**

Many actions are criminal and yet not immoral, due to bad legislation. Such are offences against the game laws, and even paltry things like muzzling offences.

On the other hand, many offences are grossly immoral, and yet they are only open to civil action, or in some cases are actually legal.

Such examples are found in cruel offences against women; also the daily financial frauds which are legalised, are a disgrace to any civilised nation.

Thus there is great necessity for **improving the law,** and there is great need of reform in **revision of sentences,** which now are so uneven.

I shall discuss the Criminal. While the **Insane are the wrecks** of society, **Criminals are the weeds.** Wrecks may be patched up, but only to continue their course in smooth waters. When storms arise, they again break down.

But you can do nothing with weeds, they must be destroyed. Yet is not the beautiful rose the descendant of the wild briar, and are not the geranium and gorgeous chrysanthemum derived from

very primitive forms? This infuses us with **hope to improve the criminal class.** Yet not in one generation. Conversely we know that well-organised minds are liable to degenerate under unfavorable conditions, and we see the same where beautiful plants are neglected, and revert to their primitive forms; this we call **Reversion of Type.**

There is a **near kin between the insane and the criminal.** Italian observers have shown that **the brain of the criminal** is of simple formation—more after the type of the imbecile and the ape. There is deficiency in actual brain structure.

Legislation bars research. We know that the microscope further reveals absence of certain important cells in the brains of those who are imbecile, and we anticipate to find the same in the criminal brains. The day will yet come when we can sort out their brains and say the owner of this brain was a thief, of that a murderer, and so forth.

But even in well-developed brains there is a **Criminal Instinct** or **Temperament,** just as there is an insane one, and that without regard to education.

The crime is then a result of bad mechanism.

The public make two divisions among criminals, sane and insane.

The previous chapter throws great light on **the insane criminal.**

It is possible that some are **monomaniacs.** For certain criminals always pursue one line of activity. One man will only steal lead (though he might not refuse silver or gold), another is a pickpocket, and probably would decline burglary. The alcoholic

craving is a monomania. When one reads of a drunkard appearing over 200 times to be fined, one must blame the State for denying the power of placing the victim under control. Consider the case of a woman who stabbed a relative to death. She had stabbed eighteen different people during her lifetime. This is evidence of a misguided judgment; a stabbing mania, probably with personal relief and satisfaction after each act. What about her offspring?

One of the most dangerous forms of insanity is epileptic or **impulsive mania.** Such people will commit the most revolting crimes, often without warning, and sometimes with apparent motive. I have described this subject in a previous chapter. The reader may also refer to somnambulism in relation to crime. Probably the latter is more frequent among us than we have any idea. It may account for those frequent changes in character which we occasionally observe. I have known two gentlemen who may go for hours into this somnambulistic condition. During these periods they transact business with various people, but were afterwards unconscious of what had occurred. This corresponded to a dream. The frontal lobe probably was asleep. It is quite probable that under similar conditions, self control being gone, some persons might commit crimes.

An **epileptic** after a crime frequently boasts of it, often feels relieved, but occasionally overcome with grief.

There are two aspects in regard to insane criminals:

1. Some have **no knowledge** of the enormity of their crime and its results.

2. Others fully realise their acts, as if they were sane, but they have **no power to resist.** This loss of will power is with difficulty understood by either judge or jury. Still the criminals are **not responsible.** Nor are **the weak-minded and melancholics** who slaughter their children that they may be saved the miseries of this world.

The Sane Criminal.

One must not lose sight of two factors—the degenerate brain and the criminal instinct. There are two causes to which the criminal is victim,

Heredity and **Environment.**

The **children of criminals** are of low type. If brought up in vice, are they not vessels of wrath fitted for destruction? Destruction may be annihilation, not pain or punishment. The potter can do what he likes with his clay (Romans ix, 14 to 24, and Jeremiah xviii and xix). He can make some vessels for honour, some for dishonour; some for mercy, and some for wrath.

Our great social error is in allowing them to multiply, and affording them so much care and protection.

Though opposed to capital punishment, one cannot ignore the fact that God ordered the prompt destruction of all those showing criminal instincts. This is fully portrayed in the **Book of Leviticus.** The object was to keep His chosen people pure and select. We see the result now, for the Jews are a

most law-abiding people, free from crime, upright in business. "Is the hand of the Lord shortened?" Ought we not to follow His ruling, and exterminate stock which is absolutely hopeless and degenerate?

Treatment.

We cannot regard criminals as of high intellect, and therefore amenable to reason. We may divide criminals into two classes:

1. **Primitive**, and
2. **Chronics.**

Primitives need not have heredity, but may be **victims of environment.**

An orphan having lost the protection of the parental wing, may have fallen into the abyss of crime, or been dragged into the whirlpool of wickedness. We must treat these first offenders on the same principle as we deal with our valuable plants that have been ruined by a storm. There is some good in them. They have been crushed by adverse surroundings. Let us do all we can to prevent them becoming chronics. As with the plants in wreckage, so let us pick them up and restore them, and put a protection around them in case the next storm will destroy them.

Chronics.

Once a criminal always a criminal, fortunately with exceptions. There should be an establishment of **colonies on the reformatory plan—curative** rather than punitive.

One sees good results in Dr. Barnardo's homes and other similar institutions, and in the Salvation

Army labour colonies. The latter deal with chronics with very encouraging results. There ought to be a **Government Department for the prevention and cure of crime.**

Criminals should be **registered** for the sake of public protection. They might be classified as **dangerous** and **non-dangerous.** The latter after a course of treatment, which should be industrial, social, and religious, might be hired out to employers of labour; or even, if sufficiently improved, returned to society.

Violent criminals must be treated on quite a different principle. For public safety they must be **isolated for ever** in labour colonies. The present penal system is a grotesque mixture. The wants of the body are carefully nurtured, whilst everything is done to induce mental torture. Thus it is no hardship, but a luxury, to the depraved and uneducated; whilst to the educated it is a living death. We must go to the lower animals for a lesson. In training a dog we must use the whip without any stint. The dog associates the sin with the physical pain, and the latter in early days acts as a deterrent; while in adult life the dog avoids wrong from the purity of its conscience and the love of its master. We resemble them in this particular. There is a powerful **craze against corporal punishment,** and **the result** is that our modern youth is weak in moral tone. When we come to the degraded types of our race, there can be no question that Corporal Punishment would influence them for good more than any other agent. It is physiolo-

gically demonstrated by brain mechanism. As a punishment it ought to be used not once but repeatedly for all cases of personal violence—a course of treatment due to the public for their protection, for we are now at the mercy of a large and powerful criminal class.

If we follow the **life history** of fifty watches or clocks we find that thirty may work well for their full period. These resemble the average healthy minds. These are "sane watches."

Ten break down soon from wear and tear. These are like the insane, whose mental machinery is not made to last.

The remaining ten watches are always in trouble, false to the end, incapable of mending, as the whole machinery is bad. These are like the criminal class—bad machinery made on the wrong principle.

Can we expect our criminals with bad machinery to act differently?

Do we not expect too much when we look for responsibility?

We cannot get over the criminal instinct or constitution any more than we can get rid of the gouty or consumptive.

It is an envelope or skin which cannot be shed by the criminal.

Can the Ethiopian change his hide, or the leopard his spots?

We can do a great deal for the gouty and the consumptive, and so with the criminal we can do much if on right principles.

But as in the constitutional diseases acute

attacks will occur, so with the improved criminal there will be outbursts, or explosions of misdirected energy. But now we act on wrong principles.

It is all purging and no healing, which is bad treatment for any disease.

This chapter applies chiefly to the criminals in the ordinary sense; but there are many persons of outward refinement and high intellectual attainments who illustrate the criminal temperament. This is constitutional just as gout, and therefore amenable to treatment. As gouty or malarious people show their type in every ailment, so the "higher" criminal is "shady" in all his transactions. They are never pure or disinterested. There is a moral squint which often becomes permanent through early neglect.

The **Figure of Justice**

is always represented blindfold, holding scales, exacting full measure of vengeance.

But the **Great Judge** before whose throne we all must stand is all-seeing, all-loving, and knows all.

In that day there will be mercy for the weak.

But those in this world who live in selfish wickedness, in luxury gained by the ruin of hearts and homes, and the grinding of the poor, will receive justice and retribution, but not vengeance.

While many of those who are now crushed in sin and sorrow and punishment, will be lifted upon the bosom of their Saviour, like the Magdalen of old.

CHAPTER XXVIII.

THE CIRCULATION OF THE BRAIN.

THE last two chapters have been so dismal, that I dare not close the book without changing the current of thought.

I would give courage and hope to the toiling pilgrim, and ask him to look on this book as a **Chart,** pointing out the safe routes, and warning him of the quicksands.

If we understand ourselves, there is opportunity for **self help** and **self improvement.**

If our bicycles break down far from home, we can soon repair them if we have a slight acquaintance with their construction. The same applies more forcibly to our brain mechanism.

As the brain is such an active organ it **requires a rich supply of blood**; while it requires special arrangements to allow of variations of pressure within the bony case.

THE BLOOD

consists of a pale yellow fluid rich in nourishment, and containing **two kinds of cells.**

There are small round cells $\frac{1}{3000}$ of an inch in diameter.

These give the **red** colour when in arteries, due

to the oxygen acting on them. But in venous blood the carbonic acid gas causes a darker shade.

These cells are formed in the **marrow of the bones,** largely about the knee.

The **white corpuscles** have been alluded to in the first chapter (see Figs. 1, 2, 3, and 4).

They are larger, and contain a fine granular structure, and a nucleus or vital spot (see Fig. 2).

They are made in the **lymphatic** and other **glands,** and find their way by the lymph canals into the blood-vessels.

They are independent individuals, and can travel about the body, in and out of the small vessels.

They are **our defenders.** If a wound occurs, and poison gets in, or germs, they congregate around the wound to shut it off from the general circulation, much the same as the London police establish a cordon round a fire to keep it from spreading.

There are **lymph glands** all over the body. They act as **filter beds.** The **lymph corpuscles** or **Leucocytes** seize on the poison to destroy it.

Thus if one has a dirty wound on the hand, a red line up the arm marks the track of the lymph canal, leading up to glands in the armpit, swollen by an extra rush of lymph corpuscles, like an extra squad of police to quell a riot.

This reveals two systems of canals in the body :

The **Blood system** to carry food and oxygen to the tissues, and bring away effete waste material;

And the **Lymphatic system,** made up of canals and filter beds, traversing every part freely in connection with the blood-vessels.

The **lymph canals** form spaces also, around

tissues, bathing them, giving them food, and helping to remove the waste. The nourishing fluid exudes from the delicate arteries into the lymph channels. The lymph canals finally open into the large veins.

Thus the **lymph system** is a sort of foreman or assistant to the blood system.

We will see how this acts in the brain-cell.

First we must study an artery. An **artery** has **three coats** (see Fig. 4). Outside a dense fibrous coat, a sort of Dunlop tyre, for support. Then a middle muscular coat, which regulates the supply of blood. Finally a thin membrane, forming a smooth lining.

All the arteries by continuous branching get smaller, and the final twigs are called **capillaries.** These capillaries only retain the delicate inner lining. This coat is so thin that both corpuscles and fluid can pass through it. The capillaries are usually surrounded by lymph spaces.

The brain-cells and dendrons or rootlets are bathed in lymph, which is kept fresh by a capillary. It is very like growing an acorn in a glass. The rootlets in the one, or dendrons in the other, absorb water or lymph, carry it to the acorn or brain cell, and energy results—in the one case in the growth of a stem, while in the other it is nerve energy.

The vigour of the brain-cell depends on the quality of the lymph and blood we supply. That is under our own control, depending on our diet. Thus acids in the blood dilate the blood-vessels;

so that gouty or other headaches may be due to acidity causing congestion.

Cerebro-spinal Fluid.

The quantity of the blood required by the brain varies, depending on its activity; in other words, the **Blood-pressure** in the skull is constantly changing.

As we breathe in, our chest expands, and suction draws more blood into the veins near the heart; consequently there is a slight fall in blood-pressure in the skull. Conversely, when we breathe out there is a little expansion of the brain, or backward pressure. This only amounts to **pulsation.** But an ingenious mechanism obtains to regulate the pressure.

There is a third fluid which exudes from the blood, and from cells. It is clear, and not much heavier than water, and of a pale straw colour. It fills up all available spaces inside the dense capsule which envelops the brain and spinal cord. It is **the cerebro-spinal fluid.** The brain contains **small cavities** or **chambers, all** communicating, and a canal continues from them down the centre of the spinal marrow. A very fine tube runs from one of these inner cavities into the outer investing sheath cavity. **This fluid thus balances the blood-pressure,** flowing from skull to spine, and out of brain, or back again, as it is wanted.

There are other methods, such as overflow into large veins, which aid in this process.

There is one way in which we often obstruct the veins coming from the brain, and that is in wearing tight collars. Many a headache is due to congestion of the brain or scalp from this simple cause. This small matter deserves attention.

The brain arteries do not take short cuts, but twist about, so as to yield easily when extra pressure is laid on, and to obviate the jerk which occurs at each pulsation.

The **Brain arteries** are derived from two sources, chiefly from the carotid artery in the neck. The other supply is from an artery running up the spine. They both unite to form a circular tube or channel on the floor of the brain, sending up many offshoots. In this way, if one artery were blocked, the others could make up any deficiency of supply.

It is the principle on which all our water companies should unite, so that the one which usually fails in the summer, autumn, and winter might make it up from other companies.

Three chief arteries come off this circle. One supplies the fore-brain, another behind supplies the sight and touch centres.

The most important is the **Middle Cerebral Artery,** which supplies most of the mid-brain. It goes to the centres of speech, trunk, and limbs.

There is great pressure on these vessels. Sometimes, if diseased, there is a great liability for them to burst. Then follows paralysis or unconsciousness and probably death.

Unfortunately the middle cerebral artery on the left side is almost in a straight line with the heart, and specially liable to catch any stray clots.

We must briefly study the heart and main vessels though so frequently described in popular books.

The Heart has **four chambers.** Two on the right side, which contain non-aërated blood.

One of these, the right auricle, receives the used-up blood from all over the body, and pumps it into the right ventricle, which pumps it through the lungs, to get purified and pick up oxygen.

The left side of the heart has also two cavities.

The left auricle receives the purified blood from the lungs, and pumps it into the left ventricle. The latter pump is very strong, as it has to send the blood all over the body.

These various chambers are closed by valves which turn them into pumps.

In certain diseases **clots** form on these valves, like seaweed or moss on stones in water. Just as a bit of weed breaks off and floats down the stream, so a little clot may break off and float into the circulation.

The left carotid artery is the highest, and in straight line of the circulation. Consequently the clot most easily slips into it and straight up to the middle cerebral.

The **middle cerebral** divides into several branches.

Fig. 17 shows how a small clot may pass up and only block the speech centre; or block the centres of the arm or leg if the clot be so large as to be arrested nearer the heart in the larger parts of the artery.

THE BLOOD-PRESSURE IN THE BRAIN

is the most important factor in health or disease.

The pressure is affected—

Mechanically, Physiologically, or **by Disease.**

Mechanically we lower the pressure when the head is raised and increase it when we stoop down. In old age or disease, when the arteries are less elastic, we are very conscious of the change in pressure by giddiness or faintness.

Many experience **giddiness** or nausea when suddenly getting up from the horizontal posture. **The Brain is too suddenly emptied of blood,** and the cells fail in their duties. The same occurs when invalids leave their beds after long illness. They even lose consciousness, and may suffer difficulty in breathing and have rapid pulse, due to the bloodlessness or anæmia of the medulla which controls these organs.

A young healthy person does not experience these changes.

There is **a physiological safety-valve** or outlet to compensate change in blood-pressure in the skull.

The abdomen is full of large blood-vessels.

When we are erect, they contract and are more empty, so that more blood can be pumped into the head.

When we are horizontal more blood would flow into the head, so these abdominal vessels relax, thus relieving the pressure.

It is for this reason that one lowers the head and body in fainting attacks. There is also a

means of relieving the brain by emptying the abdominal vessels by purgation.

In **Disease** the blood-pressure is affected in many ways.

In anæmia of the brain there is loss of function; inability for mental action, drowsiness, and often quick pulse because the regulator of the heart in the medulla also suffers.

But the blood pressure may be increased by inflammation of the delicate pia mater, the membrane which carries blood to the outer and mentally active surface of the brain.

This causes **compression.** The result is pain, slow pulse, and vomiting from the medullar centres being affected (see chapter on cranial nerves).

In more advanced stages there is drowsiness, loss of mental functions, and unconsciousness.

Even when recovery takes place the delicate cells are damaged, which necessarily alters their use afterwards.

In some forms of heart disease, when the valves leak and the pump is clogged, the veins cannot empty, and the backward pressure dilates and weakens the delicate capillaries. Then fluid from the blood exudes. We call this dropsy. If it happens in the brain, the cells are compressed, and it leads to drowsiness and failure.

As the captain is at the mercy of the crew, so the brain depends upon every part of the body.

Truly said by the apostle of old, "We are all members of one body."

SUMMARY.

I AM quite aware of the absence of that flowery and attractive diction which is the characteristic of any classical literary production.

I have missed the *suaviter in modo* whilst aiming at the *fortiter in re*. Two elements have guided my pen, heredity and environment. By the former I write what I mean, and in the plainest and shortest way. The latter indicates economy of labour, and of my reader's time.

If we take up a Waverley novel, some hours must be spent before we approach the subject. This is agreeable to many, and the style is educating. But the modern mind does not delight to feed on decoctions of delicate aroma and delicious flavour. It seeks out the essences, the extracts, and the concentrates.

Yet I trust that this book may be interesting, for the battle of life is a case of self-help from beginning to end, while we have the satisfaction of sharing with others any improvement in our own mental elevation by our influence or suggestion.

Referring to past problems, I would again emphasise the care of the young. Hedge them in from all that is evil or ugly. Fill their young minds with whatever is beautiful in thought or

form. Lead them up to noble aspirations and lofty ideas, leaving behind and below that which is undesirable, avoiding either taint or inspection thereof.

Education is usually treated in too narrow a method. It consists not only in school subjects, but also in travel and general research.

Cram the youthful minds with information on every desirable subject. Show them every kind of art and manufacture as opportunity occurs. Teach them botany, geology, natural history, and other sciences; not the deep classification, but the prominent features. Thus on a wide base they will build small towers, and according to inclination one big tower will become a hobby.

In this way our children will prefer knowledge, whether literature or science, to worldliness. It is worldliness which opens the gate to selfishness.

It is lamentable to behold how many prefer "Solomon's glory," with all its concomitant misery, to the "lilies of the field," with their associated restfulness. We see this in the earthly splendour of Monte Carlo, with its quagmire of ruin and pain; while in contrast the deep blue Mediterranean, the magnificent coast scenery, and mountain barrier show forth the beauty and power of the Creator.

Let us leave this subject to study the physical constitution of man. We have a body for digestion and assimilation of food. We are equipped with the sympathetic nervous system to manage the whole.

Superadded we have a locomotor or spinal system, while above all is added the complex brain, most of which is related to the locomotor system.

But by way of placing us above all other animals, we have a higher or intellectual brain. It is this which we must cultivate, but we cannot improve the upper while neglecting the lower.

The *mens sana* requires to be *in corpore sano*.

It is this higher intellectual brain which we must so carefully watch and study. We know that when it is damaged the nature of the individual or the "Ego" is changed. The person becomes inattentive and unnatural. This change of type resolves itself into one of two conditions; either mental defect, which is insanity, or mental perversion, which means crime.

Laying aside the sensory and motor actions of the brain, we have left two faculties—intelligence or knowing, and will-power or control. The latter, being the higher, falls first.

The "light of the body is the eye," and we all know how to read character by the face or eye. These parts are so closely related to the frontal brain that they usually express the intellectual vigour.

I have spoken of love and hate as instincts, whereas many people think the former Divine and the latter Satanic. Instinct and intelligence are inseparably interwoven; and the passions appear to be instinctive, as we observe them in the lower animals, which have no intelligence. Also the flushings, the pallor, or heat and shock which occur

in fear, love, hate, and passion, are under the control of the sympathetic nerves. But the intelligence or upper brain not only controls but guides these instincts, and may produce beautiful results. A careful examination will show this fact more clearly, though it appears a lowering of what is lovely and refined. Where, then, does the Holy Spirit come in? Let us look back to the beginning of Time.

One can imagine a grand picture of the Creation, which far eclipses the dull ideation of the Atheist or Agnostic. The Creator, after establishing the physical laws to which inert matter must submit, makes for Himself a pleasant orb and creates life (the only thing we cannot do!).

There is nothing in the Bible against Evolution, but decidedly in its favour. By studying the first chapter of Genesis in the tenth verse we read of the formation of earth and water. These are the igneous or volcanic rocks, such as we see in the granite kerbstones and the beautiful serpentine of Cornwall, and the mica which we use over our lamps.

The aqueous or sedimentary rocks are gradually laid down during the millions of years that follow.

First the slates of Cumberland and Wales are formed, which show but few signs of life through their scanty fossils. Later appear grasses, ferns, and fish in the old red sandstone and coal formations (see verses 11 and 12).

Time rolls on, and Amphibians appear. Reptiles follow, both in anatomical improvement and in geological succession, occurring in the magnesian limestone and the new red sandstones.

In verse 20 we see that birds appear later. They are a further advance on the reptiles, and came at a period when our cliffs of Dover were being laid down under the depths of a warm sea.

At a later geological time, mammals or beasts appeared; and we learn the same in the 24th verse.

Thus complex forms were built up from simpler types, and God "saw that it was good."

When everything was suitable, Man appears on the scene; only yesterday from a geological aspect, but in time probably half a million years ago. We rely for information on a few old skulls or chipped flints, and the strata they were found in. It was somewhere about the time when a cap of ice covered much of our Northern Hemisphere, and the flood from the glaciers washed down the broken flints and deposited them north of the Thames, ready for use in our gardens to-day.

The Creator bethought Himself to draw man into a closer relationship, and He breathed into his nostrils the breath of Life, and man became a living soul (chap. ii, verse 7).

Here we have a symbol, and a poetical description of how man became spiritual. Unless we assume the position of the Agnostic there is nothing illegitimate in asking, "Where is the soul of man?"

It is unwise to suppress inquiry, as it indicates an absence of self-confidence. Yet we must remember that our knowledge is limited and finite while we are dealing with a subject which is infinite, unlimited, and even beyond all human conception.

We know that consciousness is the evidence of brain activity. The term is usually applied to the higher brain cells, which we call the intellectual.

Spiritual life can only reach the human form by and through the brain cell. It is a relationship parallel to that of soil and seed; and this is described accurately in the parable of the Sower.

There are some soils in which the seed can never grow, due to mental defects. On the other side there are many soils where from lack of opportunity the seed has never been planted. While for our security and comfort we know that there is no intelligence too poor to receive the simple truths of religion; still more we know that the growth of the seed depends upon the quality of the soil, and this fact explains the variety of religious growths and outgrowths in different individuals.

In some there is much blossom but no fruit; in others there is canker, or a crooked stem which yields under pressure. Others grow in strength, bearing much fruit, and are refreshing to contemplate. There remain those who ripen after years of vigorous growth, and fall in decay and ruin from the very energy of their past vitality. They are mentally dead to this world, but we must treat them with care, absolving them from responsibility, remembering how many have enjoyed their fruits and sheltered under them in seasons of storm and blast.

It is the object of this small book to offer facts clearly and intelligently to those who are seeking such knowledge for their own help and comfort.

There is no desire to attack the many forms and instances of misdirected energy in the religious, business, and social circles; but rather to direct attention to the true cause and source.

We are now observing how the luxury and licence of individuals is gradually leading to the disintegration of empires and the decay of nations; just as surely as the dissolution of the microscopic particles of a chalk cliff would end in a certain collapse.

We are getting to prefer ease to toil, sometimes sacrificing honour and principle for gain. These are unhealthy signs. Let us be careful lest we drift towards decay, either individually or nationally.

Any process which improves the individual thus fortifies the community, and adds to the national strength.

FIGURES REFERRED TO IN THE TEXT.

Fig. 1.—Diagram of an amœba. It is simple protoplasm, capable of altering its structure to any shape. It gathers small particles of food by pushing out processes or prolongations, enclose it, and then inwardly digests the food. Several small particles are enclosed, and one is in process of being enclosed.

Fig. 2.—A white blood-corpuscle highly magnified to show the fine structure, a network of delicate fibres. It also contains two nuclei.

Fig. 3.—Three white blood-corpuscles. They resemble an amœba in their power to change their form, enclose food and digest it.

A. With two nuclei.
B. Enclosing two bacilli.
C. The bacilli partially digested.

Fig. 4.—Diagram of an artery.

A. The outside fibrous coat, fitted for strength.
B. The middle muscular coat, which causes the arteries to contract or relax as required.
C. The inside lining. A smooth thin membrane, which continues through the capillaries, and allows the white corpuscles to pass in and out of the blood-vessels.

When any part of the body is damaged or inflamed these corpuscles pass out freely in order to attack any germs which have invaded the system.

Fig. 1.

Fig. 2.

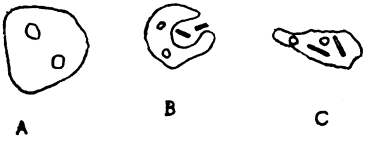

Fig. 3.

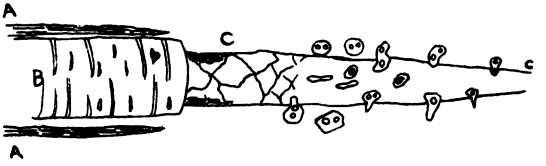

Fig. 4.

FIG. 5.—Plan of a sponge. Arrows indicate direction of fluid—the current being regulated by the action of the cilia of the living material lining the canals. The water enters by the small pores and leaves by the large pores.

These sponges are found on sea rocks and in caves. They look like wash-leather.

FIG. 6.—One of the microscopic animals found in stagnant ponds. It is covered by cilia, with which it propels itself through the water, and also wafts currents of water into the gullet so as to obtain particles of food.

FIG. 7.—A picture of the bronchial cells. These cells line the bronchial tubes and the nose. They waft up the minute particles of dust which we constantly inhale, and which otherwise would clog our air cells.

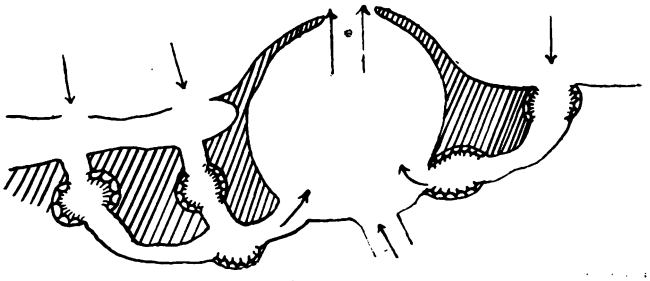

Fig. 5.

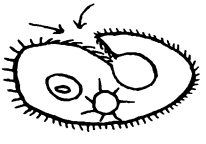

Fig. 6.

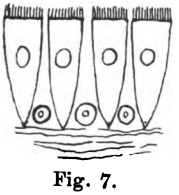

Fig. 7.

Fig. 8.—Diagram of the eye of an octopus. It is the simple type on which our eye is constructed.

C is the cornea or clear part.

L is the lens.

I. The iris, dipping into the lens.

R is the retina.

N is the optic nerve.

Refer to the diagram of the development of the brain, and of the optic nerve sprouting from it.

Fig. 9.—The eye of the nautilus. It is the simplest form of an eye. An open cup with the retina (R) exposed. N is the optic nerve.

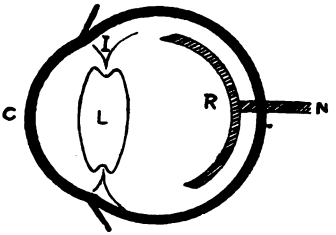

Fig. 8.

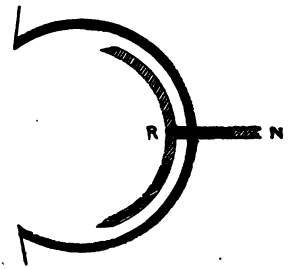

Fig. 9.

Fig. 10.—A diagram of a worm. It has a long digestive tube (D), and short legs or thorns (T) to aid crawling. The body is in muscular rings or segments. Each ring has a pair of nerve ganglia, right and left (N). Each nerve ganglion supplies its own segment, so that each segment is complete in itself; therefore there is not much inconvenience when it is chopped in pieces. These ganglia are connected in a chain the length of the body. They correspond to our sympathetic nerve ganglia, which form two chains in front of our spine or backbone. Each pair of ganglia is connected with each spinal segment of our body, for the spine is made up of several bones, one on top of each other. The lobster, cockroach, and other animals have similar nerve chains, but they have small brains superadded on account of their higher development.

Fig. 11.—A diagram of a snail. Instead of a chain of nerves it has three large ganglia;

One at the head (A),

Another in the foot (B),

And a third in connection with the stomach (C).

We correspond in having three important nerve ganglia; in the neck, the chest, and the pit of the stomach.

These nerves have no sensation, but are reflex centres.

Fig. 10.

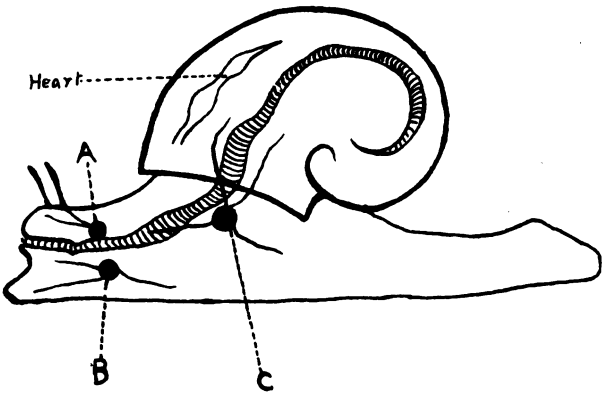

Fig. 11.

FIGS. 12 and 13.—A diagrammatic scheme of the invertebrates and vertebrates.

In Fig. 12 is represented a section of an invertebrate. A circle includes all their organs. s indicates the two nerve ganglia. These correspond to our sympathetic nerves.

Fig. 13 shows the section of a vertebrate or backboned animal. There is superadded a backbone (B), and above it a bony arch and canal (C), which encloses and protects the spinal cord or marrow (M). This spinal cord is the highway between the brain and the muscles of the body.

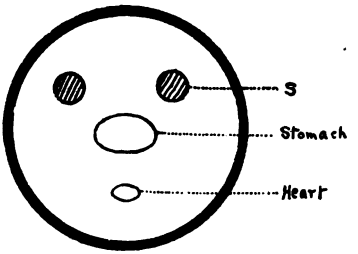

Fig. 12.

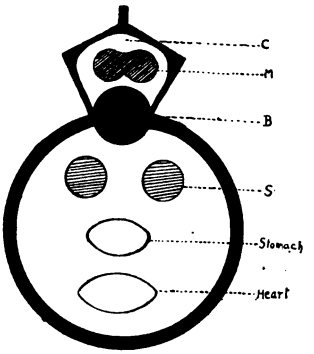

Fig. 13.

FIG. 14.—A diagram of the skull to show the large veins. Notice the skull has two layers, inner and outer (I and O). These separate at the brow to form a cavity (A), which is connected with the nose. We are conscious of it when we have catarrh and swelling in it.

B is a thickening of the skull.

V are the big veins.

V N the same veins running into the nose. Hence the relief to brain congestion afforded by nose-bleeding.

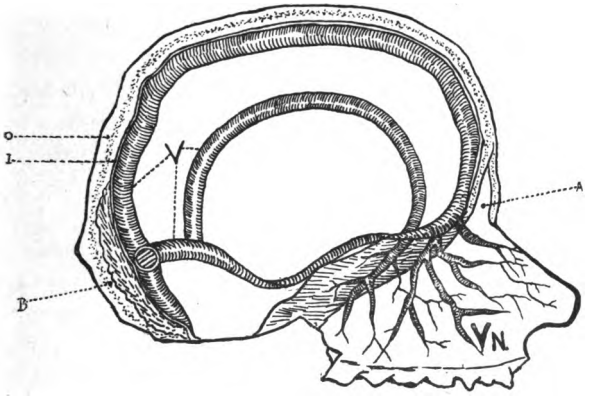

Fig. 14.

FIG. 15.—A diagrammatic idea of brain and spinal cord from the front. There are two halves, right and left.

C is on the right cerebrum.

C C is the joining band of the two hemispheres. The cerebellum is behind and does not show.

P is the pons, which is single.

M. The medulla, and

S. The spinal cord, both right and left halves.

C R. The connection between the cerebrum above, and the pons, medulla, and spine below.

s n. Sensory nerves going into spinal cord.

m n. Motor nerves leaving the spinal cord.

The sensory impulse crosses at once to the other side or half of the spinal cord, and runs up to the cortex or outer surface of the brain (*s c*). An association fibre (*a f*) sends the message on to a cell in the motor cortex (*m c*). A message is sent from here down to the medulla, where the fibres cross to the other side of the cord, and out by a motor nerve (*m n*). Thus the sensory fibres cross below and the motor fibres above. The right half of the brain governs the left half of the body, and *vice versâ*.

The spinal nerves, anterior and posterior, or motor and sensory, may be seen coming off the spinal cord and joining in one bundle (B).

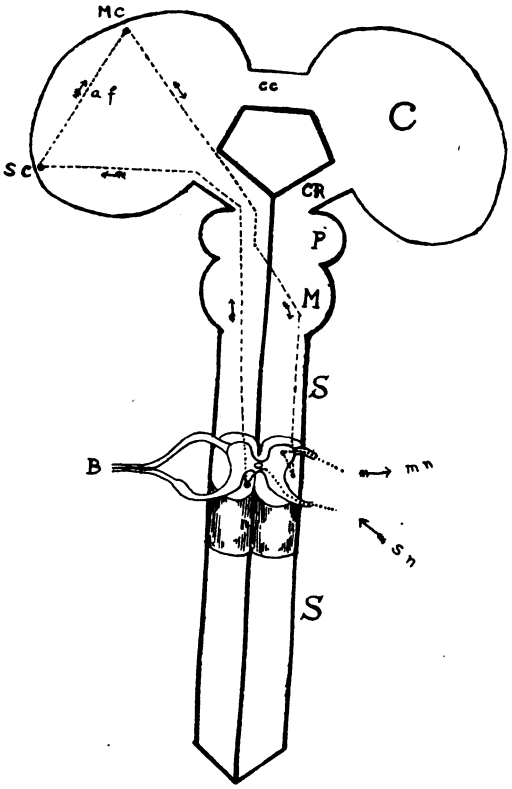

Fig. 15.

FIG. 16.—A diagrammatic view of the brain and cranial nerves from the side.

C is the cerebrum.

P F. The pre-frontal or fore-brain—"the commander." The rest of the cerebrum I call the combatant portion or mid-brain.

CB. The cerebellum, which guides all our finer movements. Note its connection with the cerebrum (1) and medulla (2).

P. The pons connecting the two halves of the cerebellum.

M. The medulla. Note the connection with the cerebrum (3).

S C is the spinal cord.

The cranial nerves are represented fairly accurately coming off from the lower brain, pons, and medulla. They have their numbers written opposite. For the functions see the chapter about cranial nerves.

Below is a cord of nerves (B) coming off the spinal cord and going to the arm and shoulder.

The X nerve is the vagus or great life controller.

I is the nerve of smell.

II is the nerve of sight.

III, IV, and VI are nerves for eye muscles.

V is the nerve of feeling to the face and to the chewing muscles.

VII is the motor nerve of the face muscles.

VIII is the hearing nerve.

IX is the nerve to the tongue and throat for feeling.

XI is the motor nerve of speech.

XII is a motor nerve to some muscles at the back of the neck.

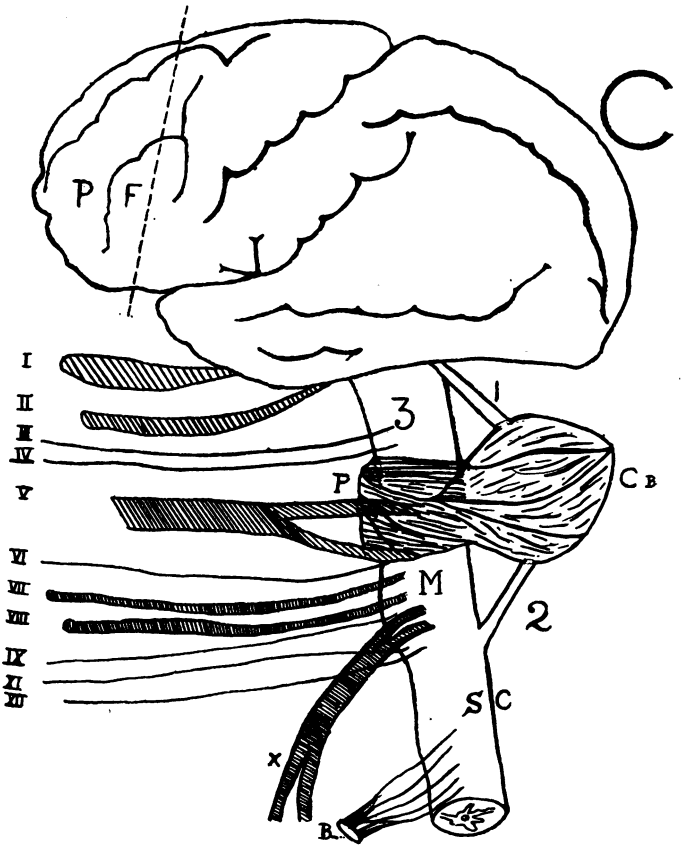

Fig 16.

Fig. 17 is a section through the motor part of the brain. It shows the thin layer of cells on the outside. This is grey, and called the cortex or bark. It is shaded.

Inside is chiefly white, made up of fibres. v indicates hollow cavities full of fluid, called the Ventricles.

The areas on each side are marked according to their functions.

On the right side tracts of fibres are shown running from the "cortical motor cells" down a narrow passage towards the medulla and the spinal cord (where it is sometimes interrupted by patches in lateral sclerosis).

On the left half is represented the artery of hæmorrhage, the bursting of which causes apoplexy. It shows branches going to the centres for speech, face, arm, leg, and trunk.

If the whole artery is shut off there is complete paralysis of the other side; but the trunk or leg often recovers first, or in part, by reason of fibres (cf) which communicate with the opposite side. The plate has been made specially diagrammatic to ensure clearness.

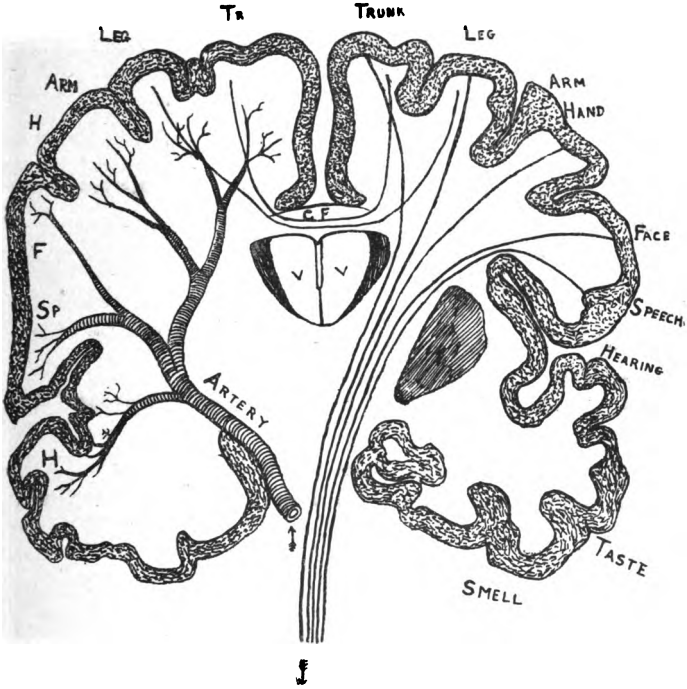

Fig. 17.

Fig. 18 shows the nerve endings in muscle-fibres—motor nerves.

A is looked at on the flat.

B in cross section.

Fig. 19.—Sensory nerve endings.

A. Touch corpuscles in the skin.

B. More sensitive touch corpuscles in lips and finger tips.

C. Taste corpuscles from the tongue.

The nerve-fibres are seen coming out below the corpuscles.

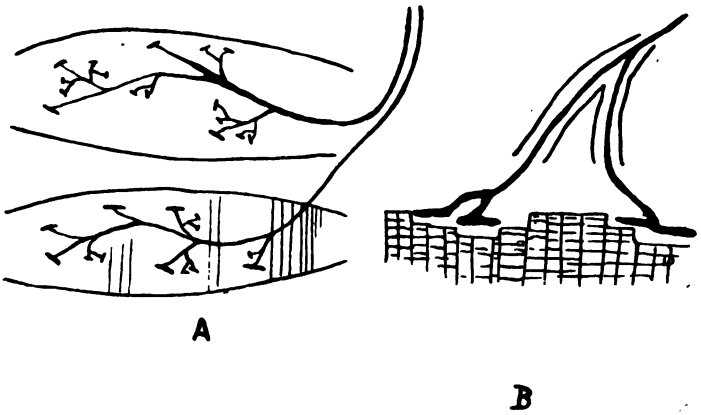

Fig. 18.

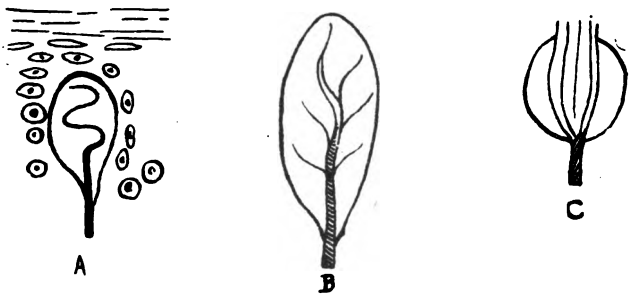

Fig. 19.

Fig. 20.—Rough diagram of the retina. It is made up of rods and cones (R C), and divided by a membrane (M) which they support. There is a layer of dark pigment-cells (P) on the surface (no pigment in albinos). Below are nerve cells (N) and fibres (F) connected with the optic nerve. The rods and cones have some red or purple pigment in parts.

When light acts on the retina this reddish or purplish colour disappears from the rods and cones, and they become shorter, varying in this according to the nature of the light; red light being the least active, yellow rays the most, which explains the discomfort of brilliant sunlight.

The colour returns in the dark and the cones elongate. It is too complex for more detail. The impulses pass by the nerve-fibres to the optic nerve and brain. See Fig. 33, showing development of the retina from the brain. The same effect on the retina is supposed to occur if the light falls on the skin and not on the eyes. The cones are absent in nocturnal animals, as owls and bats; but they have the rods.

Fig. 21 shows "Corti's cells," called after the discoverer. There are fine hairs on very sensitive cells connected with nerve-fibres. They exist in the inner ear or labyrinth, too complicated to describe fully. There are about 20,000 of them. They are supported by delicate membranes, and protected from jar by fluid, and the whole surrounded by bone, deep in the skull. The vibrations of sound pass to this fluid in the canal which encloses these cells. Different notes affect different cells. There are some cells for low tones of, perhaps, 20 vibrations per second, while the highest perceptible tones are about 30,000 vibrations per second.

It is on the same principle that the small sacs in fish and invertebrates are lined with fine hairs and contain fluid and tiny stones; this shows an immense development or addition to the primitive type.

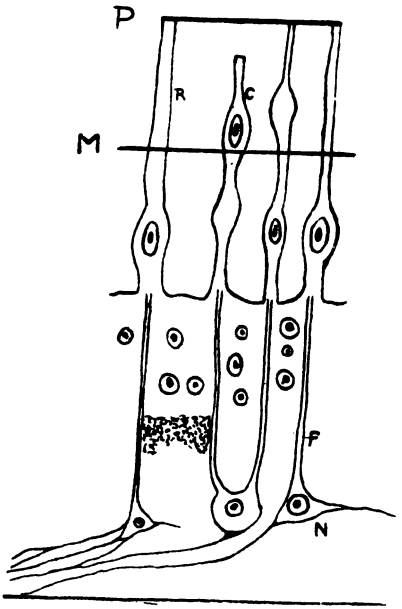

Fig. 20.

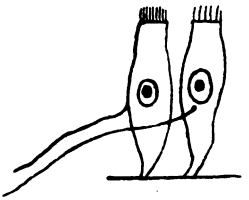

Fig. 21.

FIG. 22.—Diagram of brain-cells. The cell-body contains a nucleus (N) and an axon (A), which carries the impulse from the cell and becomes a nerve-fibre.

D shows dendrons or processes which stimulate the cell, or bring information to it.

D B are dendrons at the bases, and this is a sign of high development as in man.

F is the medullated nerve-fibre continuing from the axon to various parts of the body, or to other nerve-cells. It has an insulating sheath (I), which is called the medullary sheath. Until this sheath develops the fibre is inactive. The sheath is of special structure, but there is no advantage gained by going into detail.

FIG. 23.—Diagram of nerve-cells in the cerebellum. The striking feature is the large flask-shaped cells with innumerable branching dendrons called after the discoverer "Purkinjë's cells." There are other branching cells.

Arrows show directions of nerve motion along the axons.

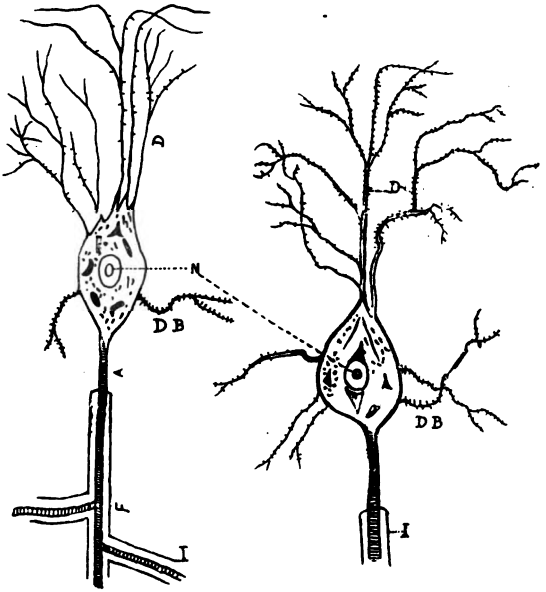

Fig. 22.

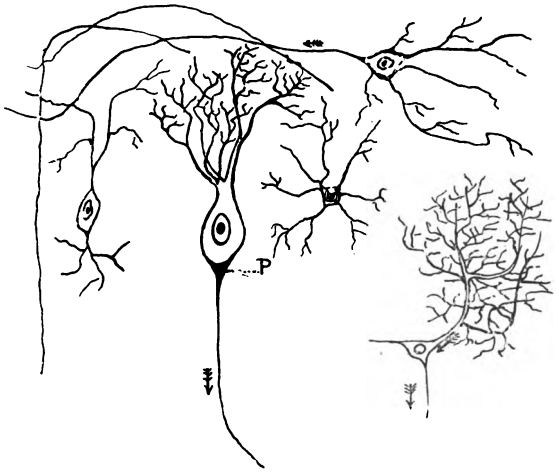

Fig. 23.

Fig. 24.—Cerebral cells in grey cortex. Quite diagrammatical.

1. Delicate vessel or artery of the fine investing membrane (the pia mater) dipping into the brain among the cells.
2. A lymph space surrounding.
3. A brain cell to nourish it, and connected with a branch of the artery.
4. Large pyramid cells sending axons down and dendrons up to the surface.
5. A small pyramid cell with an axon running up to surface to run to another cortical cell, called an association fibre, as it connects two cortical cells instead of running down to the body.
6. Medullated nerve-fibres.
7. Other cells.
8. Neuroglia cells and fibres; this is the padding in which brain cells and fibres lie.
9. A degenerated cell (would not, of course, appear in a healthy brain). The contour of the cell is irregular and broken up. The nucleus disappearing and débris in the cell. The colour and pigment also change. The fibres break up and form swellings from particles running together. (Save us from these cells!)

D = Dendrons.
D B = Basal dendron.
A = Axons.

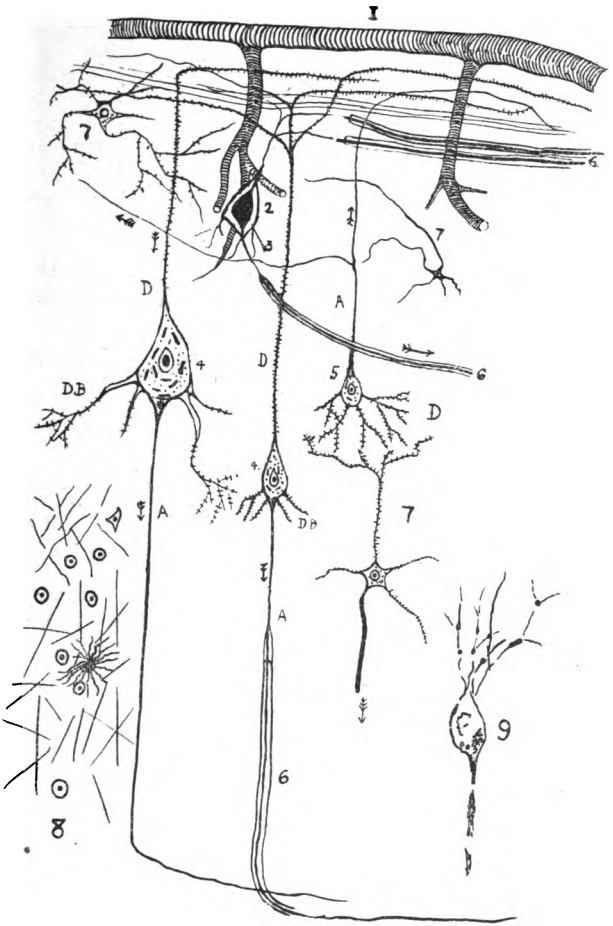

Fig. 24.

FIG. 25.—Nerve-fibres.

A. Fibres with side branches; such are found in the spinal cord, connecting the various segments above and below.

B. Simple nerve-fibrils with no sheath, as found in the sympathetic.

C. A nerve-fibre with an insulating sheath around it (1). The sheath is jointed to allow nourishment from the lymph to reach the fibres, perhaps to take away waste. Outside is a fine sheath (2). Very much exaggerated in size.

D is a cross section of nerve-fibres, showing also the insulating sheaths. It looks like a telegraph cable.

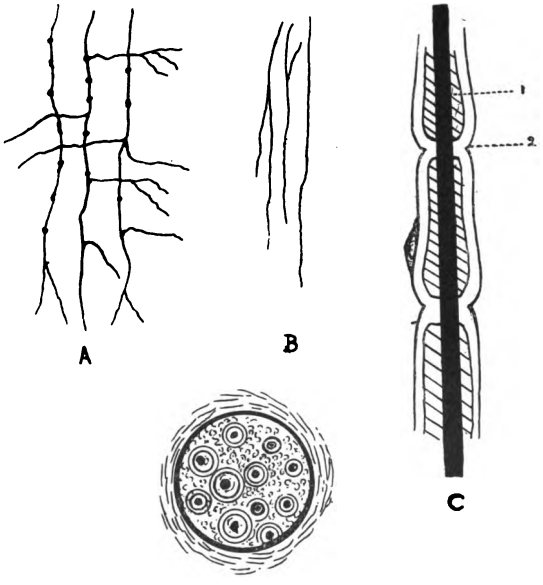

Fig. 25.

FIG. 26.—A diagram of the spinal cord.

A is the anterior or motor half.

P is the posterior or sensory half.

L marks the lateral columns which contain the bundles of fibres from the great motor areas in the brain.

A H is the anterior horn full of large motor cells. One entered, quite in a diagrammatic sense.

A R. The anterior motor roots.

P S. The posterior sensory roots.

S F. A sensory fibre crossing to the opposite half and ascending. It is interrupted at T by sclerosis or fibrous tissue. This causes the disease locomotor ataxia. The person cannot feel what he walks on, and so cannot guide his legs.

M F is a motor fibre running down the side. It has crossed from the opposite side higher up. At D it is interrupted by a fibrous patch, as in lateral sclerosis. The patient wills to make a movement with his leg, but cannot send the message. Consequently some muscles obey and some do not. The result is confusion; the limbs jerk about in aimless, unsteady fashion.

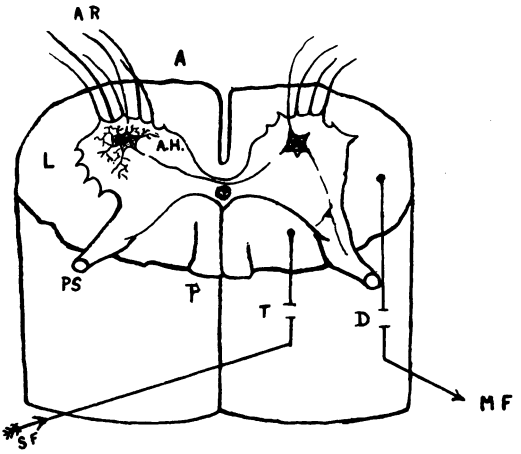

Fig. 26.

FIG. 27 shows the mechanism of swallowing. First *voluntary* on the sight of food. The impulse travels, as arrow shows, from eye round to hand, which puts the food in the mouth. If the pre-frontal is cut off by disease or experiment, the sight of food produces no response. But if the food be put in the lips, there is a reflex action through the medulla, whereby the chewing muscles grip the bolus and finish the operation.

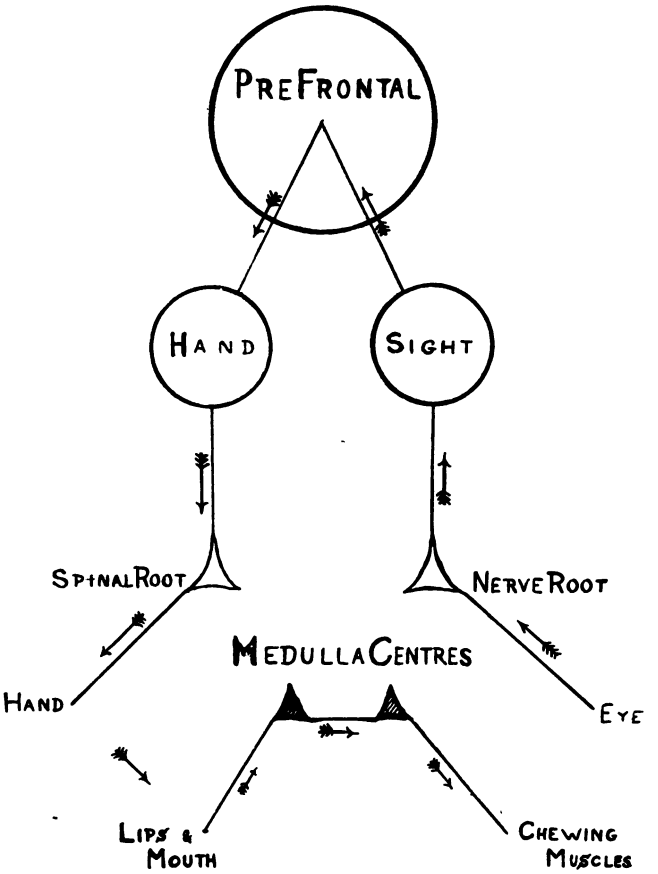

Fig. 27.

FIG. 28 illustrates reflex action, as in the secretion of saliva.

M is the mucous membrane of the tongue.

T is the nerve of taste, which is stimulated by pleasant food.

A message is received at T C, the taste centre, and sent to the secretory nerve (S N), the seventh, to stimulate the gland (G) to send saliva up the duct into the mouth. At the same time a message is sent to the sympathetic (SYM) to relax the blood-vessels (B), and allow more blood to flow through the gland and furnish the saliva.

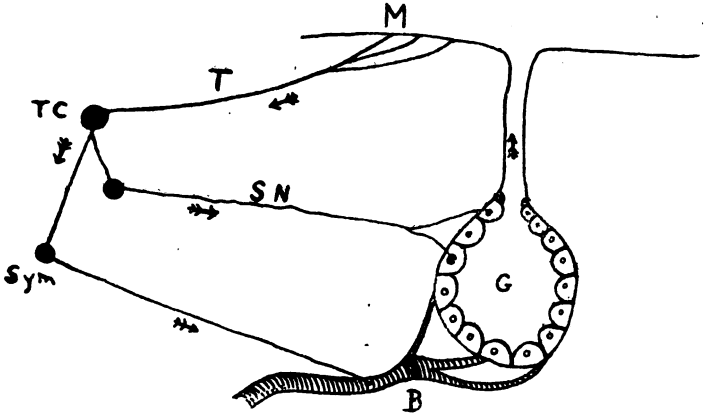

Fig. 28.

FIG. 29.—Brain areas. The motor and sensory areas are indicated by the names.

In front of the motor areas lies the pre-frontal (PF), the commander.

M is the medulla or commissariat. All between constitutes the combatant force.

Cb is the cerebellum.

P is the pons.

Sp is the spinal marrow.

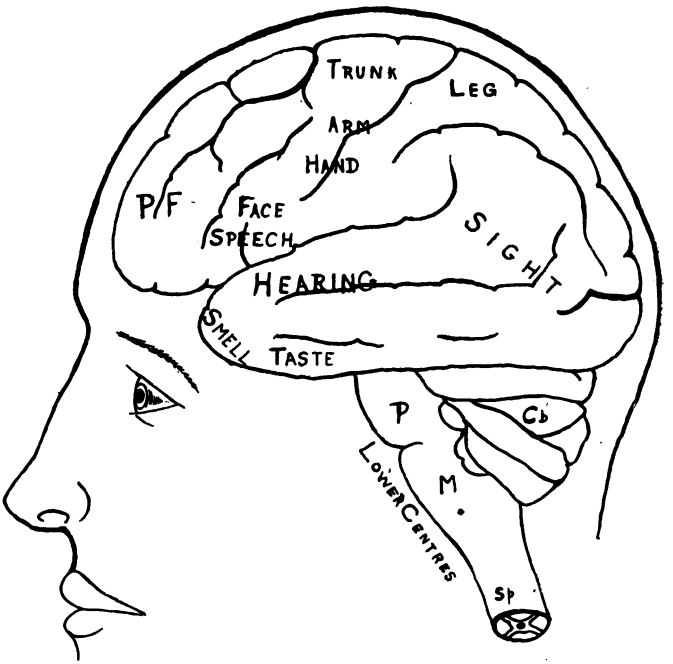

Fig. 29.

Fig. 30 shows the important nerve centres in relation to speech and writing.

The auditory word centre is only a part of the whole musical and sound centre for hearing. Similarly the visual word centre is only a part of the whole pictorial centre for sight. The impulses enter by the eye and ear to their respective nerve-roots (A and B), and thence to their nerve centres.

The arrows indicate the direction and the course of the nerve motion.

The hand and speech centres send messages to the lower nerve-centres or roots, which call the muscles to action.

This scheme shows there are many points where there may be a breakdown.

1st. In the receiving apparatus, as in disease of the eye or ear.

2nd. In their sensory nerve-roots in the medulla or lower brain.

3rd. In the sensory centre for sight or hearing;

4th. In the motor centres for hand or speech; as in apoplexy.

5th. In the motor nerve-roots in the spinal cord or medulla.

It is sometimes quite a puzzle to locate the spot of the disease.

There are routes from the optic word centre to the speech centre, and from the auditory word centre to the hand centre, but they are feeble, and I have not marked them. More usually, in reading the sound of the word has to be procured before it can be articulated.

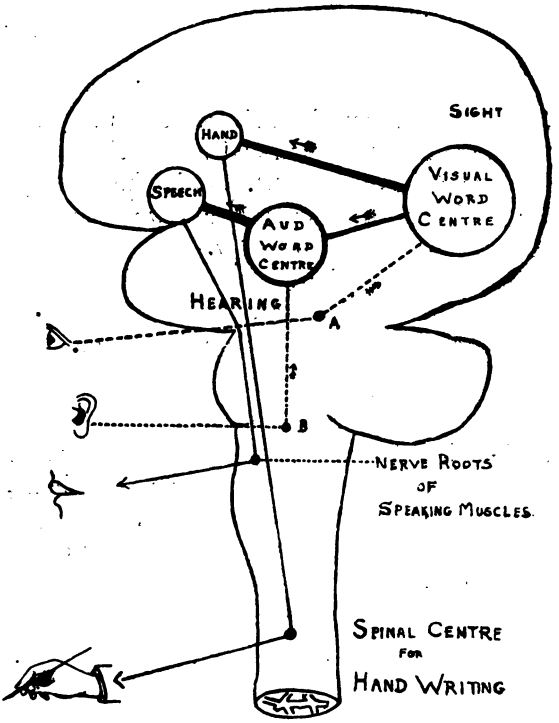

Fig. 30.

FIG. 31.—The Appendicularia, which is an invertebrate with an appendage (T), occurs with a cartilaginous rod (R), on which lies a nerve cord (N). It is the forerunner of a spine or backbone and spinal marrow; a connecting link or suggestion of what is to follow.

The nerve cord is hollow.

H shows a section thereof.

G is the central ganglion near the gullet.

FIG. 32.—The Amphioxus. The lowest vertebrate. A mere soft cartilaginous rod (R) for a backbone, with a rudimentary nerve chain (N) lying on it.

The brain is rudimentary, chiefly ganglia or masses for the nose sac (A), eye (B), and ear box (C).

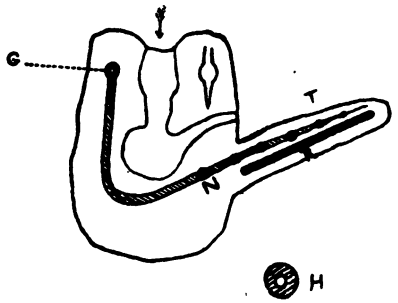

Fig. 31.

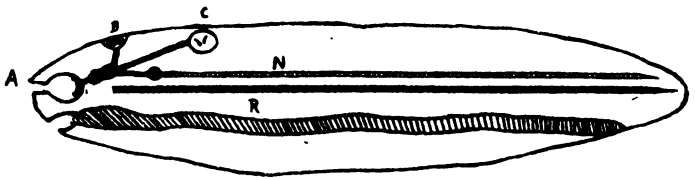

Fig. 32.

FIG. 33.—Diagrammatic representation of the early development of the brain.

A simple tube of cells, or cellular tube. It becomes constricted to represent—

Front brain (1).
Middle brain (2 and 3).
Cerebellum (CB).
The medulla (M).
The spinal cord (S).

At a later period the pre-frontal buds out (F). From the pre-frontal there are two buds: (N) the nerve of smell; (E) the optic nerve, which gets the shape of an egg-cup. The cup forms the retina of the eye.

A is a pit or depression in the mid-brain, which ultimately forms the labyrinth or internal ear.

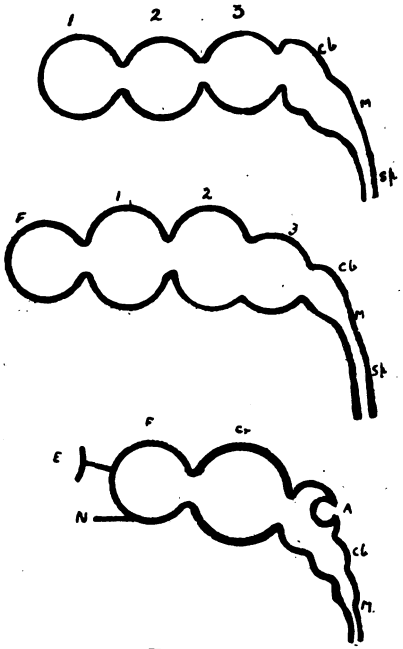

Fig. 33.

FIG. 34 shows four brains.

Sm is the smelling nerve.

Op. The optic lobe.

C. Cerebrum.

Cb. The cerebellum.

M. The medulla.

One can compare the relative development and faculties.

A is a fish with powerful smell and sight.

B. A frog. Has small cerebellum but good optics.

C. A pigeon. Has hardly any smell, but large cerebellum.

D. A rabbit. Has fair smell, but brain takes on a new type—more of a convoluted cerebrum. The mammalian type.

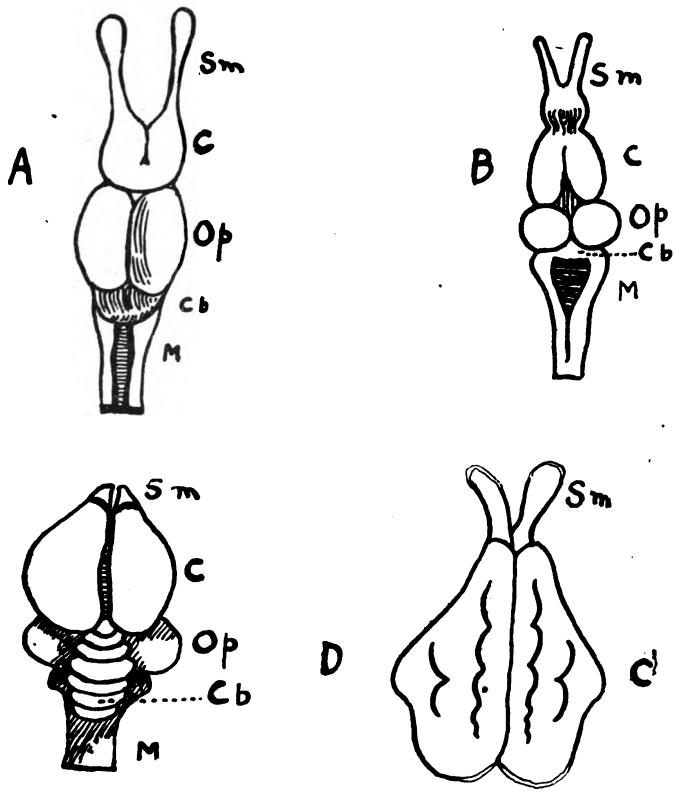

Fig. 34.

FIG. 35.—Brain of a dog.

Sm is the nerve of smell.

Cb is the cerebellum.

M is the medulla.

C is the cerebrum, which is chiefly motor areas.

The early type of our brain.

FIG. 36.—The brain of an ape.

Cb is the cerebellum.

M. The medulla.

The motor and sensory areas of the cerebrum are mapped out. They closely resemble man. The lower specimens of the human race very nearly approach this.

Note how few convolutions.

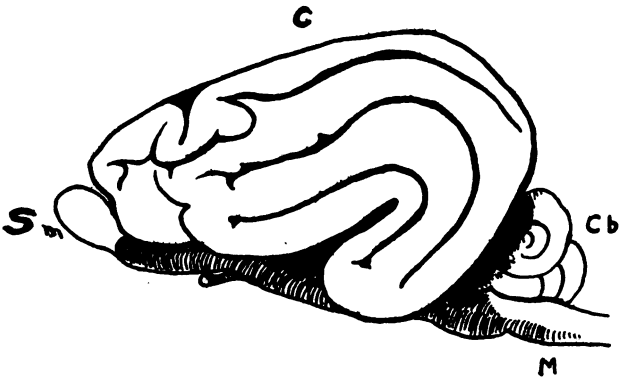

Fig. 35.

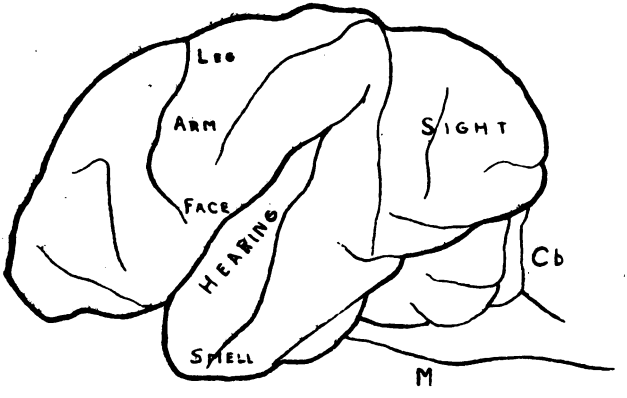

Fig. 36.

FIG. 37.—The sympathetic system. The diagram shows the skull with—

The cerebrum (C).
The cerebellum (Cb).
The medulla (M).
The pons (P).

Sp. The spinal cord, at the enlarged part where the nerve-roots pass out to the arm.
Sp1. Where the spinal nerves leave for the legs.
7C show the 7 vertebræ of the neck.
12D „ 12 „ „ back.
5L „ 5 „ „ lumbar region.
S. The sacrum, or keystone of the pelvic arch.

In front of the spine (they should be at the side) are represented the chain of sympathetic ganglia; as a rule, one for each segment or vertebra.

There are 4 behind the face, 3 large ones in the neck, 12 in the chest, and about 10 lower down.

Ca is a large plexus for the heart and lungs.
So „ „ „ stomach and digestive organs.
H „ „ „ lower abdominal organs.

They send branches in all directions, especially along the spinal nerves and blood-vessels, and to all the organs.

See the earlier chapters, where the sympathetic is shown to correspond to the ganglia in the worm, lobster, snail, and other invertebrates.

In four places the bony arches are shown behind the vertebræ forming the canal which protects the spinal cord.

[I am indebted to Mr. Douglas Pitman for assisting in the execution of these diagrams.]

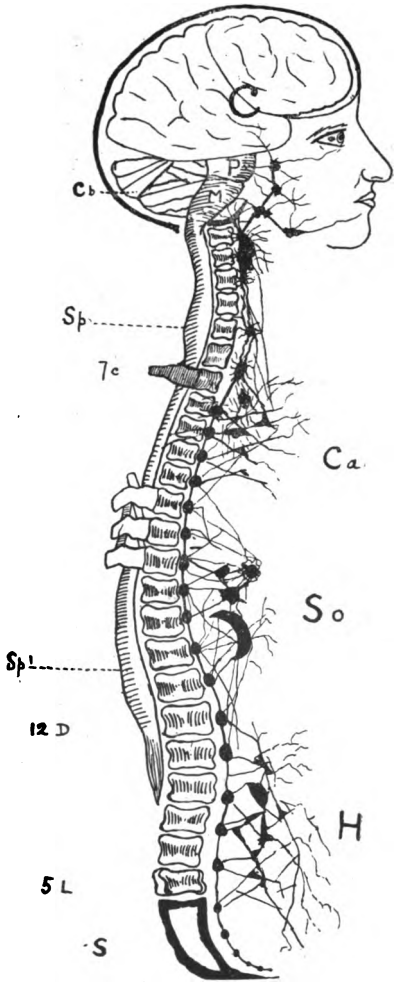

Fig. 37.

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